HUMAN HEALTH AND DISEASE (MCQS)

Note: Answers are bold and underlined:

1. Lock jaw, i.e. difficulty in opening the mouth is a symptom of:
(a) Plague (b) **Tetanus** (c) Cholera (d) None of these

2. Virus causes:
(a) Cholera (b) Typhus (c) Typhoid (d) **Measles**

3. Which of the following pairs is incorrect?
(a) Plague; Rat (b) Rabies; Dog
(c) Tapeworm; Pig (d) **Poliomyelitis; Monkey**

4. Which of the following is a fungal disease?
(a) **Ringworm** (b) Leucoderma (c) Elephantiasis (d) None of these

5. Bronchitis is a disease of which of the following organs?
(a) Blood (b) Bladder
(c) Liver (d) **Respiratory tract**

6. Acquired Immuno-Deficiency Syndrome (AIDS) is caused by:
(a) Bacterium (b) Protozoan (c) Fungus (d) **Virus**

7. Deficiency of iron in human diet causes:
(a) Goitre (b) Scurvy (c) **Anaemia** (d) Rickets

8. Trachoma is a disease of the:
(a) Liver (b) **Eyes** (c) Lungs (d) Kidneys

9. Mumps is a disease caused by:
(a) Fungus (b) Bacterium (c) **Virus** (d) None of these

10. Rickets is a disease of the:
(a) **Bones** (b) Tissue (c) Muscles (d) Blood

11. Night blindness is caused by lack of which vitamin?
(a) **Vitamin A** (b) Vitamin B (c) Vitamin C (d) Vitamin D

12. Autopsy is connected with:
(a) **Post-mortem** (b) Study of living cells (c) Cancer (d) None of these

13. Cholera is caused by:
(a) **Vibrio cholera** (b) Salmonella (c) Streptococcus (d) None of these

14. Heart attack is caused due to:
(a) Blood sugar (b) **Cholesterol** (c) Blood protein (d) Blood urea

15. Malaria is a disease which affects the:
(a) Heart (b) Lungs (c) **Spleen** (d) Kidney

16. Which of the following disease is caused by virus?
(a) **Smallpox** (b) Tuberculosis (c) Malaria (d) Cholera

17. **In human beings infection of plasmodium causes:**
(a) Tetanus (b) **Malaria** (c) Influenza (d) Typhoid

18. **Which of the following can cause cancer as well as cure it, depending upon its intensity and use?**
(a) Tobacco (b) Alcohol
(c) **Ionized radiation** (d) Ultra-violet rays

19. **DPT vaccine does not give protection to a child from:**
(a) Diphtheria (b) **Polio**
(c) Tetanus (d) Whooping cough

20. **Leukaemia is a disease of:**
(a) Skin (b) Eyes (c) **Blood cells** (d) Heart

21. **Which among the following is a water-borne disease?**
(a) Malaria (b) Influenza (c) **Cholera** (d) Viral fever

22. **The antibiotic penicillin is obtained from:**
(a) Bacteria (b) Plants (c) Sea weeds (d) **Fungus**

23. **Antibodies are:**
(a) **Protein** (b) Antigens (c) Lipids (d) None of these

24. **The disease in which bronchial tubes become narrow due to spasms of bronchial muscles is called:**
(a) Influenza (b) **Asthma** (c) Diphtheria (d) None of these

25. **Which of the following medicines is administered to patients suffering from diabetes?**
(a) Penicillin (b) **Insulin** (c) Sulpha drugs (d) Streptomycin

26. **Which of the following is NOT a vaccine-preventable disease?**
(a) Polio (b) Hepatitis B (c) **Asthma** (d) Measles

27. **Which disease mainly affects children under 5 and remains endemic in only two countries?**
(a) Rubella (b) **Polio** (c) Pneumonia (d) Measles

28. **The biggest challenges to improving global vaccine coverage are:**
(a) Limited resources (b) Competing health priorities
(c) Poor management of health systems (d) **All of these**

29. **An attenuated vaccine is composed of:**
(a) Killed micro-organisms. (b) **Living, weakened micro-organisms.**
(c) Inactivated bacterial toxins. (d) Purified macromolecules.

30. **Vaccines are available for all of the following EXCEPT:**
(a) Hepatitis A (b) Hepatitis B (c) **Hepatitis C** (d) Tetanus

CHAPTER 13

INFORMATION TECHNOLOGY

Information Technology is defined as processing and distribution of data using computer hardware and telecommunications and digital electronics. Computer is the backbone of information technology. A computer can be defined as "an electronic machine, operating under the control of instructions stored in its own memory that can accept data, manipulate the data according to specified rules, produce results and store the results for future use." Computers process data to create information.

Data is a collection of raw unprocessed facts, figures and symbols.

Information is data that is organized, meaningful and useful.

Applications of Information Technology and Computers

Computers are now being used in various fields, from education to medicine, businesses, government, science, publishing and industry.

Education: Computers have been important learning tools starting from toddlers who have computer-aided toys and apps giving them joys to the older grade/high school/college students for their research projects. Far-flung areas can now be reached and their education can now be enriched through the use of computers (online education).

Science: All the branches of science, from astronomy to zoology, depend on computers to further their knowledge. Following are the main uses of computers in scientific field:

- research and development in various disciplines,
- weather forecasting,
- forecasting of earthquakes and hurricanes,
- study of human genetics,
- astronomical observations and
- satellite launching and control.

Communication: The progress in IT and computers has given rise to the new means of communication. Internet, smart phones and wireless communication has revolutionized our lives.

Business: Computer has changed how we do business. Computer opens new doors of opportunities and ventures. Apart from the way we do business, the computer and the internet has also become our partners in doing business effectively. Now most of the business is done through the click of the mouse.

Government: Government offices also depend on computers for their basic functions. From simple letters to the more complicated projects are now being produced through the use of computers. Government agencies and their databases are now interlinked, making it easier for the agencies to monitor activities such as NADRA, banks, Telecom companies and safe city projects.

Entertainment: Computer is now an important tool in entertainment industry either it is radio, TV or cinema. The computer provides us innumerable options to handle pictures, videos, games, etc.

Engineering and Technology: Computer is used in engineering and technology to perform the tasks that are complex in nature, including:

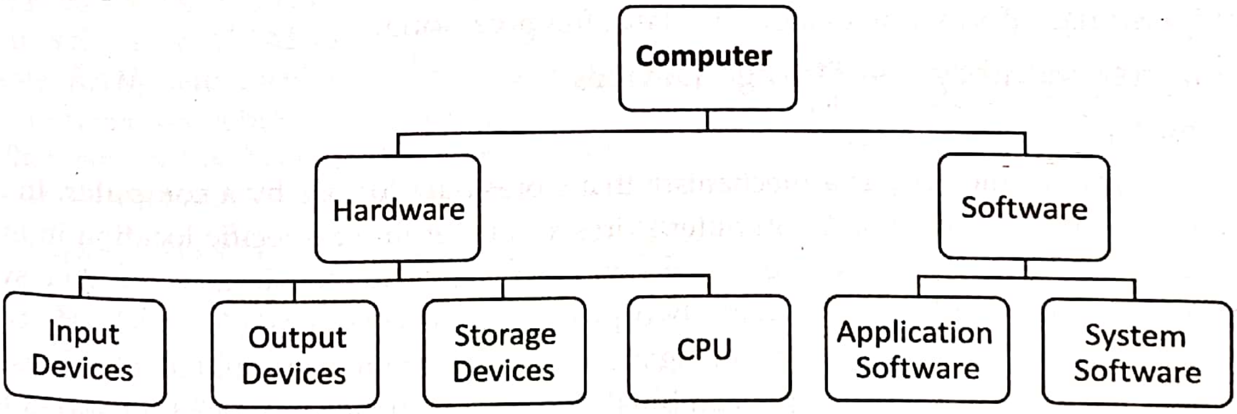
- construction and designing of buildings,
- construction of bridges and dams,
- mining,
- designing of cars and tools,

Medical Uses: In medical field computers have brought a revolution in primitive medical practices. The main uses of computer in medical field are in:

- ultrasonography,
- ECG, EEG, EMG and MRI,
- screening of blood,
- laser surgery,
- endoscopy,

HOW COMPUTERS WORK

The computer works in three stages: it accepts input (through the input devices) then processes it (CPU) and gives us the output (through output devices). Computer has the following major parts as depicted in chart:

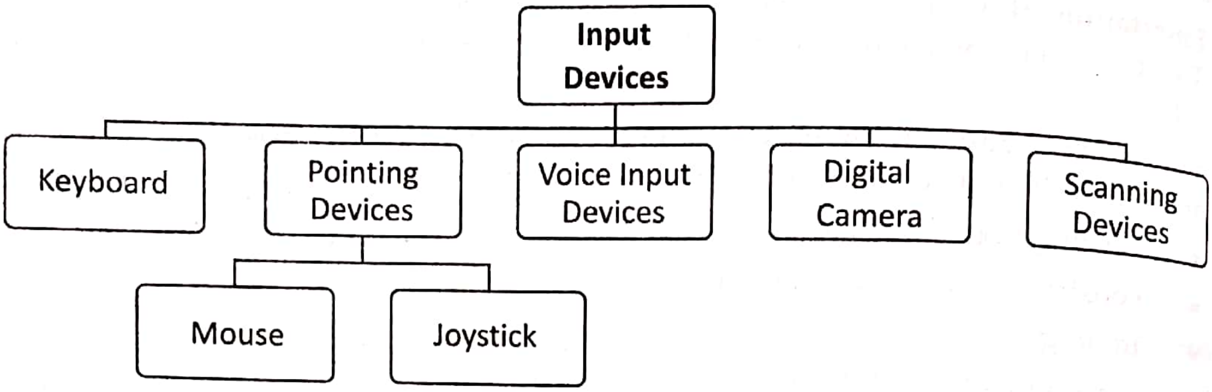


Computer Hardware

Hardware refers to the physical parts of the computer and related devices. Hardware is used to run the software. Internal devices include the hard drive, the motherboard, the video and sound cards while the external devices include the monitor, the printer, scanner, the keyboard and the mouse. Removable storages such as USB Flash Drive, CD or DVD Rom are also the examples of hardware. External devices of computer are also called *peripheral devices*. Computer hardware can be classified into input, output, storage and processing devices.

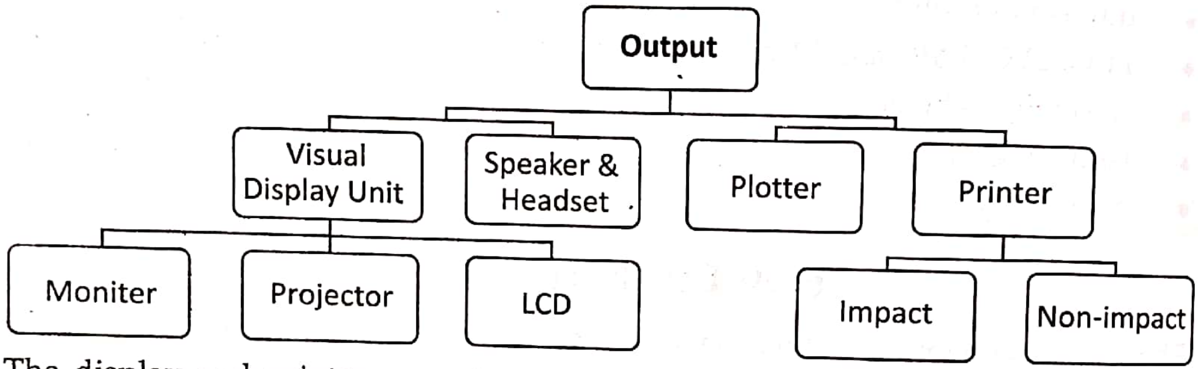
Input Devices

Input devices, such as a keyboard or mouse, permit the computer user to communicate with the computer.



Output Devices

Computer output can be in the form of a soft copy or hard copy.



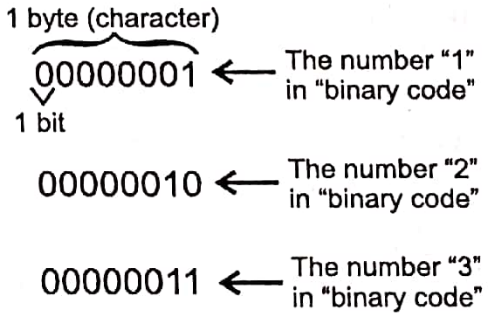
The display and printer are output devices with which the computer makes its results available to the user. A disk drive is both an input and an output device because it can either provide stored information or store the data after processing.

Computer Memory and Storage Devices

Bit and Byte

Computer memory is a mechanism that stores data for use by a computer. In a computer all data consist of numbers. A computer stores a number into a specific location in memory and later fetches the value. Most memories represent data with the binary number system. In a computer binary digits, or **bits** have two possible representations ("0" and "1", or "off" and "on"). If a second bit is added to a single bit of information, the number of representations is doubled, resulting in four possible combinations: 00, 01, 10, or 11. A third bit added to this two-bit representation again doubles the number of combinations, resulting in eight possibilities: 000, 001, 010, 011, 100, 101, 110, or 111. Each time a bit is added, the number of possible patterns is doubled. Eight bits combination is called a byte; a byte has 256 possible combinations of 0s and 1s.

A **byte** is a useful quantity to store information because it provides enough possible patterns to represent the entire alphabet, in lower and upper cases, as well as numeric digits, punctuation marks, and several character-sized graphic symbols, including non-English characters. A byte also can be interpreted as a pattern that represents a number between 0 and 255.


1 byte (character)
00000001
1 bit
The number "1" in "binary code"
00000010
The number "2" in "binary code"
00000011
The number "3" in "binary code"

- A ***kilobyte*** is equal to 1,024 bytes and can store about 1,000 characters.
- A ***megabyte*** can store about 1 million characters, a *gigabyte* can store about 1 billion characters and a *terabyte* can store about 1 trillion characters or 1024 GB.

Computer memory may be divided into two broad categories known as internal memory and external memory.

Internal Memory or Primary Memory

Internal memory operates at the highest speed and can be accessed directly by the central processing unit (CPU). Internal memory is contained on computer chips and uses electronic circuits to store information. ROM, RAM, etc. are examples of internal memory.

Read-Only Memory (ROM)

ROM is a memory containing hard wired instructions that the computer uses when it boots up (start up). Before the system software loads in the computer, the instructions are read from a small programme in the ROM called "BIOS". The storage of programme and data in the ROM is permanent. The ROM can only be read by the CPU but it cannot be changed. ROM is non-volatile memory.

Random Access Memory (RAM)

RAM (Random Access Memory) received its name from its ability to directly access any memory cell. RAM is made up of small memory chips that form a memory module. These modules are installed in the RAM slot on the motherboard of the computer. The processor is able to read and write from RAM faster than any other storage media on the computer. Therefore, adding more RAM will increase processing speed. RAM is temporary storage as data only remains there when the machine is running. When we shut down the computer, RAM loses all of its data. When we start its back up, the operating systems and our others files are loaded from the hard disk and into RAM.

External Memory or Secondary/Auxiliary Memory

External memory can generally be classified as either magnetic or optical. In computers, magnetic storage can take these forms:

1. Magnetic disk, that includes Floppy disk and Hard disk drive.
2. Magnetic tape, used for tertiary and off-line storage.
3. Optical forms currently in common use are: CD, DVD, CD-R, DVD-R, DVD, etc.

The Central Processing Unit

The central processing unit or CPU is a microprocessor chip that is, a single piece of silicon containing millions of tiny, microscopically-wired electrical components. Information is stored in a CPU memory location called a register. When a programme is running, one special register called the programme counter keeps track of which programme instruction comes next by maintaining the memory location of the next programme instruction to be executed. CPU is called brain of the computer. The CPU is divided into separate units for its operation. These are arithmetic logical unit and control unit.

Arithmetic Logical Unit (ALU)

Arithmetic Logical Unit performs the actual processing of data and instruction. The major operations performed by the ALU are addition, subtraction, multiplication, division, logic and comparison. Data is transferred to ALU from storage unit when required. After processing, the output is returned back to storage unit for further processing or getting stored.

Control Unit (CU)

The next component of computer is the Control Unit, which acts like the supervisor seeing whether things are being done in proper fashion. The control unit determines the sequence in which computer programmes and instructions are executed. Thereby it coordinates the activities of computer's peripheral equipment as they perform the input and output. Therefore, it is the manager of all operations.

Most modern CPUs are microprocessors, meaning they are contained on a single integrated circuit (IC) chip. An IC that contains a CPU may also contain memory, peripheral interfaces, and other components of a computer; such integrated devices are variously called microcontrollers or systems on a chip (SoC). Some computers employ a multi-core processor, which is a single chip containing two or more CPUs called "cores"; in that context, single chips are sometimes referred to as "sockets".

Computer Software

Computer software, or simply software, is that part of a computer system that consists of encoded information or computer instructions, in contrast to the physical hardware from which the system is built. The term "software" was first proposed by Alan Turing and used in this sense by John W. Tukey in 1957. In computer science and software engineering, computer software is all information processed by computer systems, programmes and data. Computer software includes computer programmes, libraries and related non-executable data, such as online documentation or digital media. Computer hardware and software require each other and neither can be realistically used on its own. Based on the goal, computer software can be divided into: Application software and system software.

Application software, which is software that uses the computer system to perform special functions beyond the basic operation of the computer itself. There are many different types of application software, such as business applications, office, entertainment and learning applications.

System software, which is software that directly operates the computer hardware, to provide basic functionality needed by users and other software, and to provide a platform for running application software. System software includes:

- **Operating systems,** which are essential collections of software that manage resources and provides common services for other software that runs "on top" of them. Operating systems are windows, iOS Macintosh, Unix etc.

- **Utilities**, which are computer programmes designed to assist users in the maintenance and care of their computers.

NETWORK

A network is a group of two or more computers that intelligently share resource such as, hardware software and data devices with each other.

Advantages of a Network

In addition to reducing hardware costs by sharing expensive printers and other peripherals among multiple users, networks provide additional benefits to users:

- a single Internet connection can be shared among multiple computers;
- resource sharing such as printers and storage device;
- electronic mail (email) and instant messages can be sent and received;
- multiple users can share access to software and data files;
- files and folders can be backed up to local or remote shares;
- audio and video content can be streamed to multiple devices;
- multiple users can contribute to a single document using collaboration features;
- remote-control/access programs can be used to troubleshoot problems or show new users how to perform a task and
- video conferences;

Classification of Computer Networks

Several types of networks exist, from small two-station arrangements, to internet that connects the whole world. Computer networks are classified based on various factors. They include: Geographical span, Inter-connectivity, Administration and Architecture. Generally, networks are distinguished based on their geographical span.

Local Area Network

A computer network spanned inside a building and operated under single administrative system is generally termed as Local Area Network (LAN). Usually, LAN covers an organization offices, schools, colleges or universities. Number of systems connected in LAN may vary from at least as two to many. LAN provides a useful way of sharing the resources between end users. The resources such as printers, file servers, scanners, and internet are easily sharable among computers.

Metropolitan Area Network

A Metropolitan Area Network is a large computer network that spans a metropolitan area or campus. Its geographic scope falls between a WAN and LAN. MANs provide Internet connectivity for LANs in a metropolitan region, and connect them to wider area networks like the Internet.

Wide Area Network

As the name suggests, the Wide Area Network (WAN) covers a wide area which may span across provinces and even a whole country. Generally, telecommunication networks are Wide

Area Network. These networks provide connectivity to MANs and LANs. Since they are equipped with very high speed backbone, WANs use very expensive network equipment.

Internetwork, or internet

A network of networks is called an internetwork, or simply the internet. It is the largest network in existence on this planet. The internet hugely connects all WANs and it can have connection to LANs and Home networks.

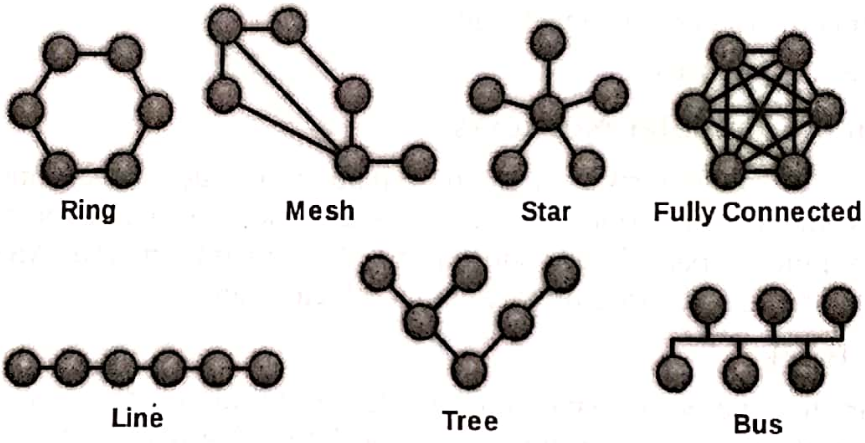
Essentials of a Network or Network Components

At a minimum, each network requires the following:

- Physical (cable) or wireless (radio frequency) connections between computers.
- A common set of communications rules, known as a network protocol.
- Software that enables resources to be served to or shared with other network-enabled devices and that controls access to the shared resources.
- Resources that can be shared, such as printers, drives, modems, media players.
- Software that enables computers to access other computers sharing resources (servers).

Network Topology

A Network Topology is the arrangement with which computer systems or network devices are connected to each other. Topologies may define both physical and logical aspect of the network. Both logical and physical topologies could be same or different in a same network.



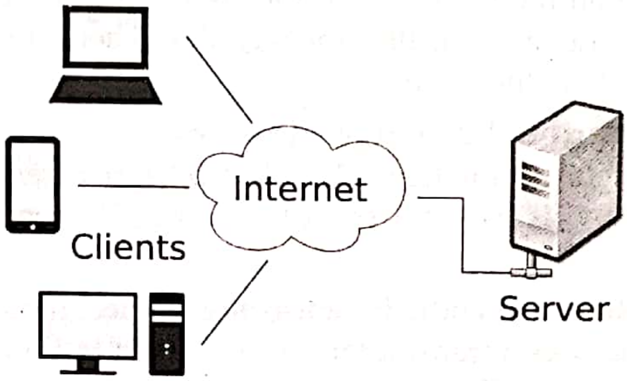
In general the more interconnections there are, the more robust the network is; but the more expensive it is to install. Common layouts are the following:

- A **bus network**: all nodes are connected to a common medium along this medium.
- A **star network**: all nodes are connected to a special central node. This is the typical layout found in a Wireless LAN, where each wireless client connects to the central Wireless access point.
- A **ring network**: each node is connected to its left and right neighbour node, such that all nodes are connected and that each node can reach each other node by traversing nodes left- or rightwards.
- A **mesh network**: each node is connected to an arbitrary number of neighbours in such a way that there is at least one traversal from any node to any other.

- A **fully connected network:** each node is connected to every other node in the network.
- A **tree network:** nodes are arranged hierarchically.

INTERNET

Internet is the computer-based global information system. The Internet is composed of many interconnected computer networks. Each network may link tens, hundreds, or even thousands of computers, enabling them to share information and processing power. The Internet has made it possible for people all over the world to communicate with one another effectively and inexpensively.



How Information Travels Over the Internet

All information is transmitted across the Internet in small units of data called *packets*. Software on the sending computer divides a large document into many packets for transmission; software on the receiving computer regroups incoming packets into the original document.

The set of **protocols** used for the Internet are the Transmission Control Protocol (TCP) and the Internet Protocol (IP). TCP/IP protocols enable the Internet to automatically detect and correct transmission problems. For example, if any network or device malfunctions, protocols detect the failure and automatically find an alternative path for packets in order to avoid the malfunction. Protocol software also ensures that data arrives complete and intact. If any packets are missing or damaged, protocol software on the receiving computer requests that the source resend them. Only when the data has arrived correctly does the protocol software make it available to the receiving application programme, and therefore to the user.

TELECOMMUNICATION

Telecommunication is science and practice of transmitting information by electromagnetic means. Telecommunication can be defined as devices and systems that transmit electronic or optical signals across long distances. Telecommunication usually involves a sender of information and one or more recipients linked by a technology, such as a telephone system, that transmits information from one place to another.

Wireless Communication

Wireless communication is among technology's biggest contributions to mankind. Wireless communication involves the transmission of information over a distance without help of wires, cables or any other forms of electrical conductors. The transmitted distance can be anywhere between a few meters (for example, a television's remote control) and thousands of kilometres (for example, radio communication). Some of the devices used for wireless communication are cordless telephones, mobiles, GPS devices wireless computer parts, and satellite television.

Types of Wireless Communication

The different types of wireless communication mainly include, IR wireless communication, satellite communication, broadcast radio, Microwave radio, Bluetooth etc.

Satellite Communication: Satellite communication is one type of self-contained wireless communication technology. It is widely spread all over the world to allow users to stay connected almost anywhere on the earth. When the signal (a beam of modulated microwave) is sent near the satellite then, satellite amplifies the signal and sent it back to the antenna receiver which is located on the surface of the earth.

Infrared Communication: Infrared wireless communication communicates information in a device or systems through IR radiation. IR is electromagnetic energy at a wavelength that is longer than that of red light. It is used for security control, TV remote control and short range communications.

Broadcast Radio: Mostly an audio broadcasting service, radio broadcasts sound through the air as radio waves. Radio uses a transmitter which is used to transmit the data in the form of radio waves to a receiving antenna. Radio waves are electromagnetic signals, that are transmitted by an antenna. These waves have completely different frequency segments, and you will be ready to obtain an audio signal by changing into a frequency segment.

Microwave Communication: Microwave wireless communication is an effective type of communication. In this communication, the data or information can be transferred using two methods. One is satellite method and another one is terrestrial method. Wherein satellite method, the data can be transmitted through a satellite. In terrestrial method, in which two microwave towers with a clear line of sight between them are used, ensuring no obstacles to disrupt the line of sight. So, it is used often for the purpose of privacy. The main disadvantage of microwave signals is, they can be affected by bad weather, especially rain.

Wi-Fi: The wireless network is operating three essential elements that are radio signals, antenna and router. The radio waves are keys which make the Wi-Fi networking possible. Wi-Fi is used by various electronic devices like smart phones, laptops, etc. These networks allow users to connect only within close proximity to a router. Wi-Fi is very common in networking applications which affords portability wirelessly.

Mobile Communication Systems: Many users communicate across a single frequency band through mobile phones. Cellular and cordless phones are two examples of devices which make use of wireless signals. Typically, cell phones have a larger range of networks to provide a coverage. But, Cordless phones have a limited range. Similar to GPS devices, some phones make use of signals from satellites to communicate.

Bluetooth Technology: The main function of the Bluetooth technology is that permits you to connect various electronic devices wirelessly to a system for the transferring of data. Cell phones are connected to hands free earphones, mouse, and wireless keyboard.

Advantages of Wireless Communication

- Any data or information can be transmitted faster and with a high speed.
- Maintenance and installation is less costly for these networks.
- The internet can be accessed from anywhere wirelessly.

Disadvantages of Wireless Communication

- An unauthorized person can easily capture the wireless signals which spread through the air.
- It is very important to secure the wireless network so that the information cannot be misused by unauthorized users.

SOCIAL NETWORKING

Social Networking refers to grouping of individuals and organizations together via some medium, in order to share thoughts, interests, and activities. There are several web based social network services available such as Facebook, Twitter, LinkedIn, Google+ etc. which offer easy to use and interactive interface to connect with people with in the country an overseas as well. There are also several mobile-based social networking services in form of apps such as WhatsApp, hike, Line Pinterest, Tinder, Instagram, Skype, Snapchat, Tumblr etc. Some of the famous social networking services provided over web and mobile are give below.

- **Facebook:** Allows to share text, photos, video, etc. It also offers interesting online games.
- **Twitter:** Twitter allows the user to send and reply messages in form of tweets. These tweets are the small messages, generally include 140+ characters.
- **LinkedIn:** LinkedIn is a business and professional networking site.
- **WhatsApp:** It is a mobile-based messaging app. It allows to send text, video, and audio messages.
- **YouTube:** YouTube is video sharing service that allows users to watch videos posted by other users and upload videos of their own. The slogan of YouTube is "Broadcast yourself."

Applications of Social Networking

Government Applications: Social networking is more recently being used by various government agencies. Social networking tools serve as a quick and easy way for the government to get the opinion of the public and to keep the public updated on their activity. In Pakistan political parties has turned to social media to spread their message.

Online Marketing and Advertisement: Website like Facebook allows users to create a page for specific product, community or firm and promoting over the web.

Online Jobs: Website like LinkedIn allows users to create connection with professionals and helps to find the suitable job based on one's specific skills set.

Online News: On social networking sites, people also post daily news which helps us to keep us updated.

Education: Social networking sites help a lot to share knowledge and information related to college and university tasks. Students share assignments reading materials, eBooks and homework.

Business Applications: Applications for social networking sites have extended toward businesses and brands are creating their own web links to promote their brands.

Entertainment: Social media has also become a source of entertainment. Different people, group of people and organizations share photos, videos and other infotainment material.

Chatting: Social networking allows us to keep in contact with friends and family. We can communicate with them via messages through WhatsApp, Instagram etc.

Share Picture, Audio and Video: One can share picture, audio and video using social networking sites.

Advantages of Social Networking

- Facilitates open communication, leading to enhanced information discovery and delivery.
- Many social networking sites incorporate an instant messaging feature, which lets people exchange information in real-time via a chat. Twitter has become the fastest source of news and information around the globe.
- When you opt to participate in a social network community, you can pick and choose individuals whose likes and dislikes are similar to yours and build your network around those commonalities.
- Allows people to discuss ideas, post news, ask questions and share links.
- Provides an opportunity to widen business contacts.
- Targets a wide audience, making it a useful and effective recruitment tool.
- Improves business reputation and client base with minimal use of advertising.
- Expands market research, implements marketing campaigns, delivers communications and directs interested people to specific web sites.

Disadvantages of social networking

- Opens up the possibility for hackers to commit fraud and launch spam and virus attacks.
- Increases the risk of people falling prey to online scams that seem genuine, resulting in data or identity theft.
- Social media is a time waster. Social media is the most popular use of the Internet — surpassing email — and smartphones.
- Social networking invites major corporations to invade privacy and sell our personal information.
- People can steal one's identity and open an account on one's name by posting his/her picture and can harm his/her friends and family.
- Use of social networks may expose individuals to other forms of harassment or even inappropriate content.
- Children could be exposed to pornography or other inappropriate content.
- It is the prime cause of generational increase in narcissism.

- Online bullying, also called cyber-bullying, is a relatively common occurrence and it can often result in emotional trauma for the victim.

OPTICAL FIBRE

Optical fibre refers to the medium and the technology associated with the transmission of information as light pulses along a hollow glass tube or plastic wire or fibre. Fibre optics is the branch of science which deals with optical fibres.

If light hits glass at a really shallow angle (less than 42 degrees), it reflects back in again — as though the glass were really a mirror. This phenomenon is called *total internal reflection*. It's one of the things that keeps light inside the pipe.

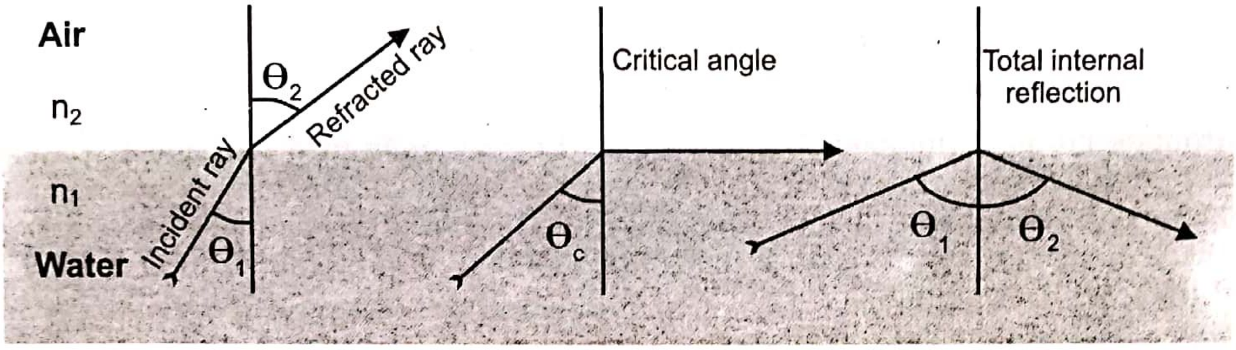


Figure: Total internal reflection

Basic Structure of an Optical Fibre

An optical fibre consists of four parts: the **core**, the **cladding**, and the **coating** or **buffer** and an extra **jacket**. Light propagates mainly along the core of the fibre. The core is generally made of glass. The core is surrounded by a layer of material called the **cladding**. The cladding is generally made of glass or plastic. The cladding performs the following functions:

- Reduces loss of light from the core into the surrounding air
- Reduces scattering loss at the surface of the core
- Protects the fibre from absorbing surface contaminants
- Adds mechanical strength

For extra protection, the cladding is enclosed in an additional layer called the **coating** or **buffer**. The **coating** or **buffer** is a layer of material used to protect an optical fibre from physical damage. The material used for a buffer is a type of plastic. The buffer is elastic in nature and prevents abrasions. And the last one the Jacket is used to bundle all fibres in one cable.

Fibre optic cable's **jackets** are available in different colours that can easily make us recognize the exact colour of the cable we are dealing with. The colour yellow clearly signifies a single mode cable, and orange colour indicates multimode.

Optical Fibre Types

Optical fibres are classified into two types. The first type is single mode fibres. The second type is multimode fibres. The basic structural difference is the core size.

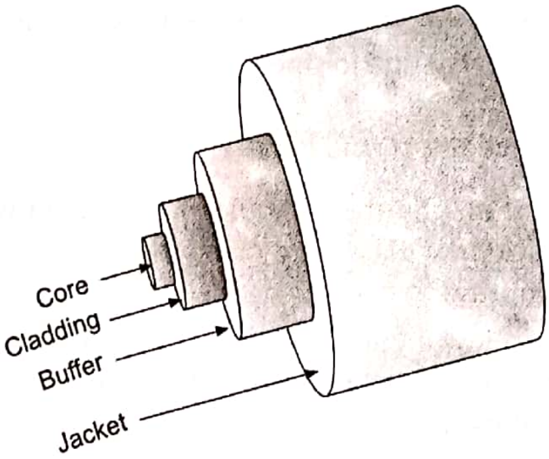


Figure: Optical Fibre Structure

Multimode Fibre: Multimode fibre is designed to carry more than one signal at a time. Each carries multiple rays or modes concurrently, each at a slightly different reflection angle with the optical fibre core. Multimode fibre transmission is used for relatively short distances because the modes tend to disperse over longer lengths. Commonly used for hauling traffic over short distances, such as within a building.

Single-mode Fibre: Single-mode fibre is optical fibre that is designed to carry a single signal at a time. It is used mainly for long distance signal transmission. Single-mode fibre has a narrow core, and the index of refraction between the core and the cladding changes less than it does for multimode fibres. Light thus travels parallel to the axis, creating little pulse dispersion. Telephone and cable television networks install millions of kilometres of this fibre every year.

How does Fibre Optic Communication Works?

Unlike copper wire based transmission where the transmission entirely depends on electrical signals passing through the cable, the fibre optics transmission involves transmission of signals in the form of light from one point to the other. Furthermore, a fibre optic communication network consists of transmitting and receiving circuitry, a light source and detector devices.

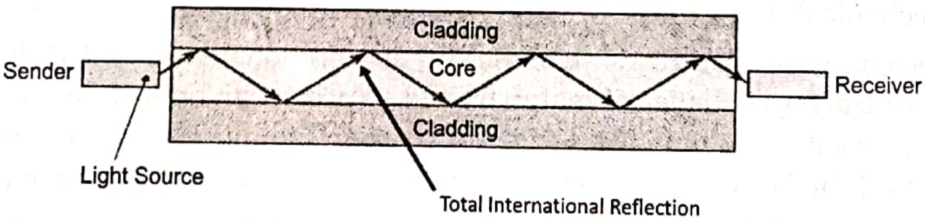


Figure: Fibre Optic Communication

When the input data, in the form of electrical signals, is given to the transmitter circuitry, it converts them into light signal with the help of a light source. This source is of LED whose amplitude, frequency and phases must remain stable and free from fluctuation in order to have efficient transmission. The light beam from the source is carried by a fibre optic cable to the destination circuitry wherein the information is transmitted back to the electrical signal by a receiver circuit.

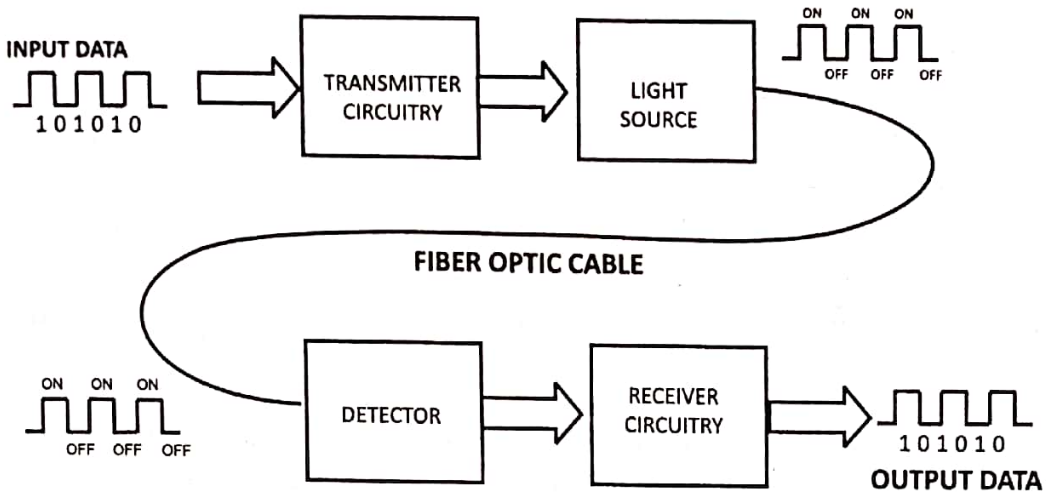


Figure: Process of Communication through Optical Fibre

The Receiver circuit consists of a photo detector along with an appropriate electronic circuit, which is capable of measuring magnitude, frequency and phase of the optic field. This type of communication uses the wavelengths near to the infrared band that are just above the visible range. Both LED and Laser can be used as light sources based on the application.

Fibre Optic Cable Advantages over Copper

Bandwidth — Fibre optic cables have a much greater bandwidth than metal cables. The amount of information that can be transmitted per unit time of fibre over other transmission media is its most significant advantage. With the high performance single mode cable used by telephone industries for long distance telecommunication, the bandwidth surpasses the needs of today's applications and gives room for growth tomorrow.

Low Power Loss — An optical fibre offers low power loss. This allows for longer transmission distances. In comparison to copper, in a network, the longest recommended copper distance is 100 m while with fibre, it is 2000 m.

Interference — Fibre optic cables are immune to electromagnetic interference. It can also be run in electrically noisy environments without concern as electrical noise will not affect fibre.

Size — In comparison to copper, a fibre optic cable has nearly 4.5 times as much capacity as the wire cable has and a cross sectional area that is 30 times less.

Weight — Fibre optic cables are much thinner and lighter than metal wires. They also occupy less space with cables of the same information capacity. Lighter weight makes fibre easier to install.

Safety — Since the fibre is a dielectric, it does not present a spark hazard.

Security — Optical fibres are difficult to tap. As they do not radiate electromagnetic energy, emissions cannot be intercepted. Fibre is the most secure medium available for carrying sensitive data.

Flexibility — An optical fibre has greater tensile strength than copper or steel fibres of the same diameter. It is flexible, bends easily and resists most corrosive elements that attack copper cable.

Cost — The raw materials for glass are plentiful, unlike copper. This means glass can be made more cheaply than copper.

Disadvantages

Cost — Cables are expensive to install but last longer than copper cables.

Transmission — Transmission on optical fibre requires repeating at distance intervals.

Fragile — Fibres can be broken or have transmission loses when wrapped around curves of only a few centimetres radius. However, by encasing fibres in a plastic sheath, it is difficult to bend the cable into a small enough radius to break the fibre.

Protection — Optical fibres require more protection around the cable compared to copper.

Uses for optical fibres

Telecommunication — Telecommunication uses fibre optic cables. Optical fibres transmit energy in the form of light pulses. The optical fibres can handle tens of thousands of conversations simultaneously.

Medical uses — Optical fibres are well suited for medical use. They can be made in extremely thin, flexible strands for insertion into the blood vessels, lungs, and other hollow parts of the body. Optical fibres are used in a number of instruments that enable doctors to view internal body parts without having to perform surgery.

General uses — The simplest application of optical fibres is the transmission of light to locations otherwise hard to reach. Bundles of several thousand very thin fibres assembled precisely side by side and optically polished at their ends, can be used to transmit images.

CELL PHONE

A cellular phone is a telecommunication device that uses radio waves over a networked area (cells) and is served through a cell site or base station at a fixed location, enabling calls to transmit wirelessly over a wide range, to a fixed landline or via the Internet.

In this networked system, the cellular phone is identified as a mobile system consisting of the equipment and SIM card that actually assigns the mobile telephone number. A cellular phone is also known as a cell phone or mobile phone. It is a complex radio, but still a radio. In order to really understand the way a cell phone works, we must discuss some of the cell phones history for just a moment.

Back around the early 1950s, cell phones were really only used in automobiles. But these mobile-radio-phones were literally like driving around with an entire telephone company in one's car. In select urban areas, there were large, central antennas that were specifically allocated for these radio phones. Each car that had a radio-phone required a big antenna that could transmit at least 40 or 50 miles. Since radio technology itself was only in the building phase, only about 25 *channels* were available for private use. So basically only 25 people could be talking on their radio-phones at the same time. And in cities this was a problem. For there were more than just 25 people who had radio phones in their cars.

The Cell Approach: The solution to this problem was to divide each city up into small divisions, or "cells". All cellular telephone systems exhibit several fundamental characteristics, as summarised in the following:

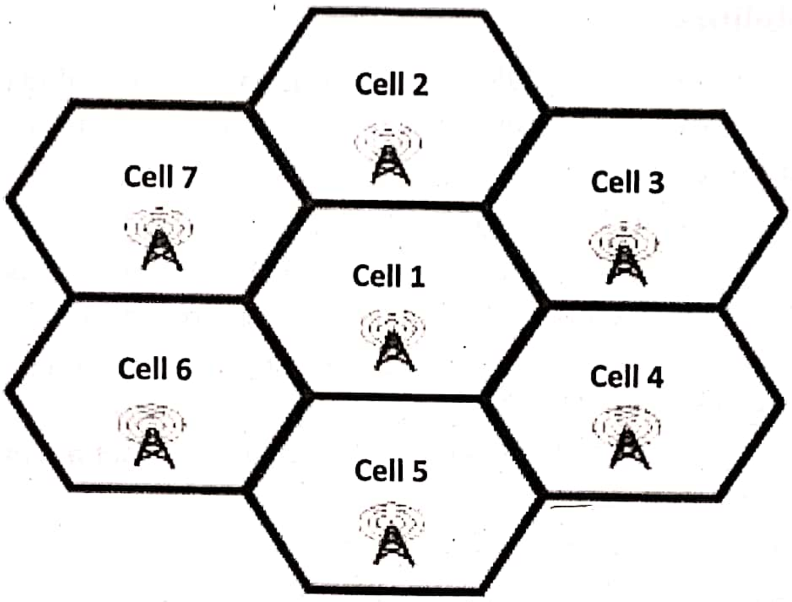


Figure: Cells or divisions

1. The geographic area served by a cellular system is broken up into smaller geographic areas, or cells. Uniform hexagons most frequently are employed to represent these cells on maps and diagrams; in practice, though, radio waves do not confine themselves to hexagonal areas, so the actual cells have irregular shapes.
2. All communication with a mobile or portable instrument within a given cell is made to a base station that serves the cell.
3. Because of the low transmitting power of battery-operated portable instruments, specific sending and receiving frequencies assigned to a cell may be reused in other cells within the larger geographic area. Thus, the spectral efficiency of a cellular system (that is, the uses to which it can put its portion of the radio spectrum) is increased by a factor equal to the number of times a frequency may be reused within its service area.
4. As a mobile instrument proceeds from one cell to another during the course of a call, a central controller automatically reroutes the call from the old cell to the new cell without a noticeable interruption in the signal reception. This process is known as handoff. The central controller, or mobile telephone switching office (MTSO), thus acts as an intelligent central office switch that keeps track of the movement of the mobile subscriber.
5. As demand for the radio channels within a given cell increases beyond the capacity of that cell (as measured by the number of calls that may be supported simultaneously), the overloaded cell is "split" into smaller cells, each with its own base station and central controller. The radio-frequency allocations of the original cellular system are then rearranged to account for the greater number of smaller cells.

Frequency reuse between disjoint cells and the splitting of cells as demand increases are the concepts that distinguish cellular systems from other wireless telephone systems. They allow cellular providers to serve large metropolitan areas that may contain hundreds of thousands of customers.

Cell phone Capabilities

Today, many cell phones are called smartphones and are capable of doing almost anything a computer is capable of doing. They perform various functions such as:

- take and make calls to any other person with a phone;
- send and receive text messages;
- take, view, and store pictures and videos using a built-in camera;
- access the Internet, e-mail, chat, and even download apps for the phone;
- play games and have access to common programmes, such as a calculator, contacts, calendar, clock, to-do list, etc;
- remotely control other devices connected to the Internet or connected via Bluetooth;
- store and run files and
- play music and watch movies

Cell Phone structure

Modern digital cell phones can process millions of calculations per second in order to compress and decompress the voice stream. Cell phone contains just a few individual parts:

- a circuit board containing microprocessor,
- ROM and RAM,
- an antenna,
- a liquid crystal display (LCD),
- a keyboard,
- a microphone,
- a speaker and
- a battery

The circuit board is the heart of the system. The microprocessor handles all of the functions for the keyboard and display, deals with command and control signalling with the base station and also coordinates the rest of the functions on the board. The ROM and RAM chips provide storage for the phone's operating system and customizable features, such as the phone directory.

The Computerisation of Mobile Devices

Just like computers, mobile phones and tablets need operating systems to power these devices. Here are the three most popular smartphone operating systems based on new smartphones sold.

- **Android:** Developed by Google and can be found in devices made by a variety of manufacturers such as Samsung, Q mobile, HTC etc.
- **iOS:** Developed by Apple and it runs on iPhones, iPad tablets, and iPod touch music devices.
- **Blackberry OS:** Developed by Research in Motion and it runs on the Blackberry devices favoured by many corporate IT departments.

Mobile Apps

If mobile devices are becoming more like computers they also need programmes that can run on these devices. Developers are creating "apps" or mini-applications for phones that extend the basic functionality of phone or tablet. Many apps are free, while others charge a small fee, all of which are designed to enhance one's phone or tablet experience. Applications that cell phone owners can take advantage of include word processing, calendars, mobile banking, web surfing, alarms, memos, video streaming, games and much more.

ARTIFICIAL INTELLIGENCE (AI)

Artificial Intelligence (AI) is the study and engineering of intelligent machines capable of performing the same kinds of functions that characterize human thought.

John McCarthy, who coined the term Artificial Intelligence in 1956, defines it as "the science and engineering of making intelligent machines", especially intelligent computer programmes. Intelligence relate to tasks involving higher mental processes. Examples: creativity, solving problems, pattern recognition, classification, learning, induction, deduction, building analogies, optimization, language processing, knowledge and many more. Intelligence is the computational part of the ability to achieve goals. AI gives four possible goals to pursue:

- Systems that think like humans
- Systems that act like humans
- Systems that think rationally
- Systems that act rationally

Applications of Artificial Intelligence

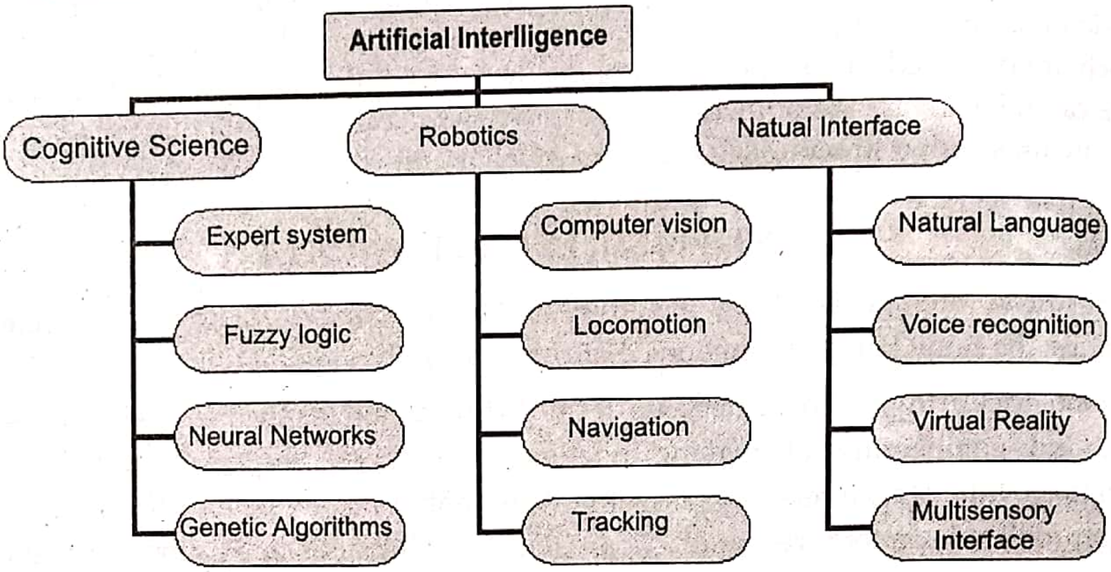
AI applications may be classified under three major areas such as cognitive science, robotics, and natural interface. However, these classifications overlap each other sometimes. Figure given below shows major application areas of AI.

Cognitive Science

This area of AI is based on research on biology, neurology, psychology, mathematics, etc. It focuses on researching how the human brain works and how humans think and learn. The results of such research in human information processing are the basis for the development of a variety of computer-based applications in AI.

- **Expert Systems:** An expert system is a knowledge-based information system that uses its knowledge about a specific, complex application area to act as an expert consultant to end users. Expert systems can provide decision support to end users in the form of advice from an expert consultant in a specific problem area.
- **Neural Network:** Massively parallel neurocomputer systems whose architecture is based on the human brain's mesh-like neuron structure. Such networks can process many pieces of information simultaneously and can learn to recognize patterns and programmes themselves to solve related problems on their own.
- **Fuzzy Logic:** A computer-based system that can process data that are incomplete or only partially correct, i.e. fuzzy data. Such systems can solve unstructured problems with incomplete knowledge as humans do.

- **Genetic Algorithms:** Genetic algorithms use sets of mathematical process rules (algorithms) that specify how combinations of process components or steps are to be formed.



Robotics

Basic disciplines of robotics include AI, Engineering and physiology. This technology produces robot machines with computer intelligence and computer controlled, human like physical capabilities. This area includes applications designed to give robots the following powers of

- **Visual perception:** sight
- **Tactility:** ability use the sense of touch
- **Dexterity:** ability in using hands skilfully
- **Locomotion:** physical ability to move over any surface
- **Navigation:** the intelligence to properly find ways to a destination

Natural interface Applications

Development of natural interfaces is essential to the natural use of computers by humans. This area of applications are designed for

- **Natural languages and Speech recognition:** Ability to communicate with computers and robots in conversational human languages and have them understand us as easily as we understand each other.
- **Multisensory Interfaces:** Development of multisensory devices that use variety body movements to operate computers.
- **Virtual reality:** Using multisensory human computer interfaces that enable human users to experience computer simulated objects, spaces, activities and worlds as they actually exist.

Real World Applications of AI

Artificial intelligence has been used in a wide range of fields including medical diagnosis, stock trading, robot control, law, remote sensing, scientific discovery and toys. A lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it's not labelled AI anymore.

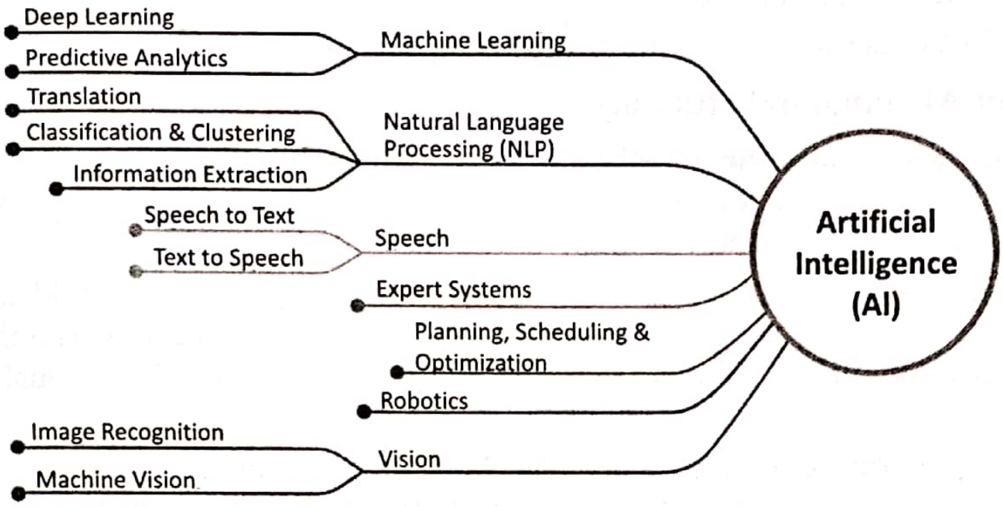


Figure: Applications of AI

AI in daily life

- Communications
- Time management
- Health and safety
- Education
- Goals, informational needs
- Games, recreation, activities
- Products, purchases, marketing
- Augmentation of cognition

AI in Science

- Automated discovery
- Design of experiments
- Triaging of resources
- Interpretation of data
- Probing complexity

AI and Infrastructure

- Transportation
- Commerce decision making
- Agriculture
- Engineering and architecture
- Power and conservation

AI and the Consumers

- Evolving relationship with computation

- Sensing, reasoning and learning
- Personalized smart applications
- Products and services
- Challenges and opportunities with data and privacy

Fears about AI replacing Humans

Experts warn that "the substitution of machinery for human labour" may "render the population redundant." They worry that "the discovery of this mighty power" has come "before we knew how to employ it rightly."

Stephen Hawking, Elon Musk and others wonder whether AI could get out of control, precipitating a sci-fi conflict between people and machines. Others worry that AI will cause widespread unemployment, by automating cognitive tasks that could previously be done only by people.

The most alarming scenario is of rogue AI turning evil, as seen in countless sci-fi films. But although AI systems are impressive, they can perform only very specific tasks: a general AI capable of outwitting its human creators remains a distant and uncertain prospect. The more pressing question is what impact AI might have on people's jobs and way of life.

Each time, in fact, technology ultimately created more jobs than it destroyed, as the automation of one chore increased demand for people to do the related tasks that were still beyond machines. Replacing some bank tellers with ATMs, for example, made it cheaper to open new branches, creating many more new jobs in sales and customer service. Similarly, e-commerce has increased overall employment in retailing. As with the introduction of computing into offices, AI will not so much replace workers directly as require them to gain new skills to complement it.

As technology changes the skills needed for each profession also changes. Workers will have to adjust. That will mean making education and training flexible enough to teach new skills quickly and efficiently.

INFORMATION SYSTEMS

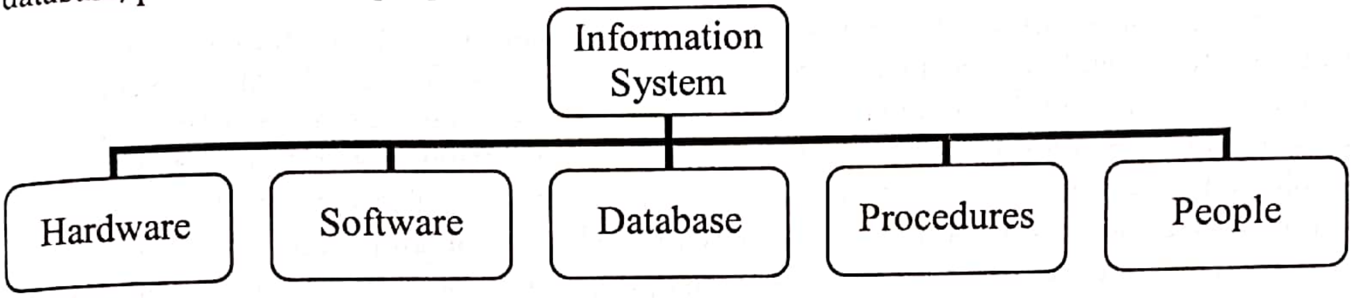
An information system can be defined as "a software system to capture, transmit, store, retrieve, manipulate, or display information, thereby supporting people, organization, or other software systems." It is necessary to remember that Information system is not a software alone it's a combination of different components.

Business firms and other organizations rely on information systems to carry out and manage their operations, interact with their customers and suppliers, and compete in the marketplace. Information systems are used to run inter-organisational supply chains and electronic markets. For instance, corporations use information systems to process financial accounts, to manage their human resources, and to reach their potential customers with online promotions.

Many major companies are built entirely around information systems. These include eBay, a largely auction marketplace; Amazon, an expanding electronic mall and provider of cloud computing services; Alibaba, a business-to-business e-marketplace; and Google, a search engine company that derives most of its revenue from keyword advertising on Internet searches. Governments deploy information systems to provide services cost-effectively to citizens.

Components of Information Systems

An information system is essentially made up of five components: hardware, software, database, procedures and people.

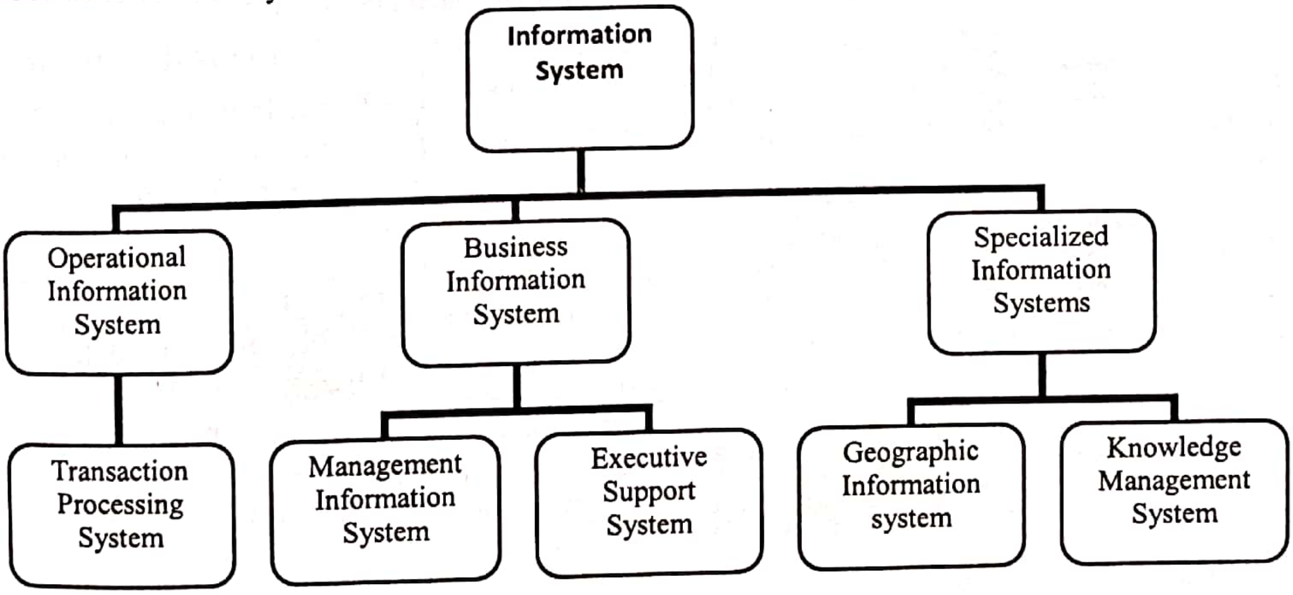


These five components integrate to perform input, process, output, feedback and control.

- **Hardware:** A computer and its peripheral equipment: input, output and storage devices; hardware also includes data communication equipment.
- **Software:** These are the programmes used to organize, process and analyze data.
- **Databases:** Information systems work with data, organized into tables and files.
- **Procedures:** These describe how specific data are processed and analyzed in order to get the answers for which the information system is designed. Rules for achieving optimal and secure operations in data processing.
- **People:** Information systems, professionals and users who analyses organizational information needs, design and construct information systems, write computer programmes, operate the hardware, and maintain software.

Types of Information Systems

It is difficult to classify the many types of information systems that have emerged in practice. Many classifications for information systems exist in the literature. Information systems are broadly classified into operational information systems, business information systems and specialised information systems.


Information System
Operational Information System
Business Information System
Specialized Information Systems
Transaction Processing System
Management Information System
Executive Support System
Geographic Information system
Knowledge Management System

Operational Information systems are generally used by managers at lower levels of the organization — those who run day-to-day business operations and make fairly routine decisions.

Transaction Processing Systems (TPS)

Transaction processing systems (TPS) meet the data collection, storage, processing and outputting functionalities for the core operations of a business. TPS can be of various kinds such as payroll systems, fund management systems, Budgeting systems, sales management systems, etc. A payroll TPS is a typical accounting transaction processing system found in most firms. A payroll system keeps track of the money paid to employees. The master file is composed of discrete pieces of information (such as a name, address, or employee number) called data elements. Data are keyed into the system, updating the data elements. The elements on the master file are combined in different ways to make up reports of interest to management and government agencies and to send pay checks to employees. These TPS can generate other report combinations of existing data elements.

Business Information Systems (BIS)

Business intelligence systems can be complex as they identify, extract and analyse data for various operational needs, particularly for decision-making purposes. BIS may provide analyses that predict future sales patterns, summarize current costs and forecast sales revenues. Business information systems collect data from the various data warehouses in an organization and provide management with analyses according to lines of business, department or any breakdown that management desires. For example, financial institutions use BIS to develop credit risk models that analyse the number and extent of lending or credit given to various sectors. These systems may use various techniques and formulas to determine the probability of loan defaults.

Management Information Systems (MIS)

The main objective of MIS is to provide lower and middle management with printed or electronic reports with inquiry capabilities so that they can control, organize and plan more effectively and efficiently.

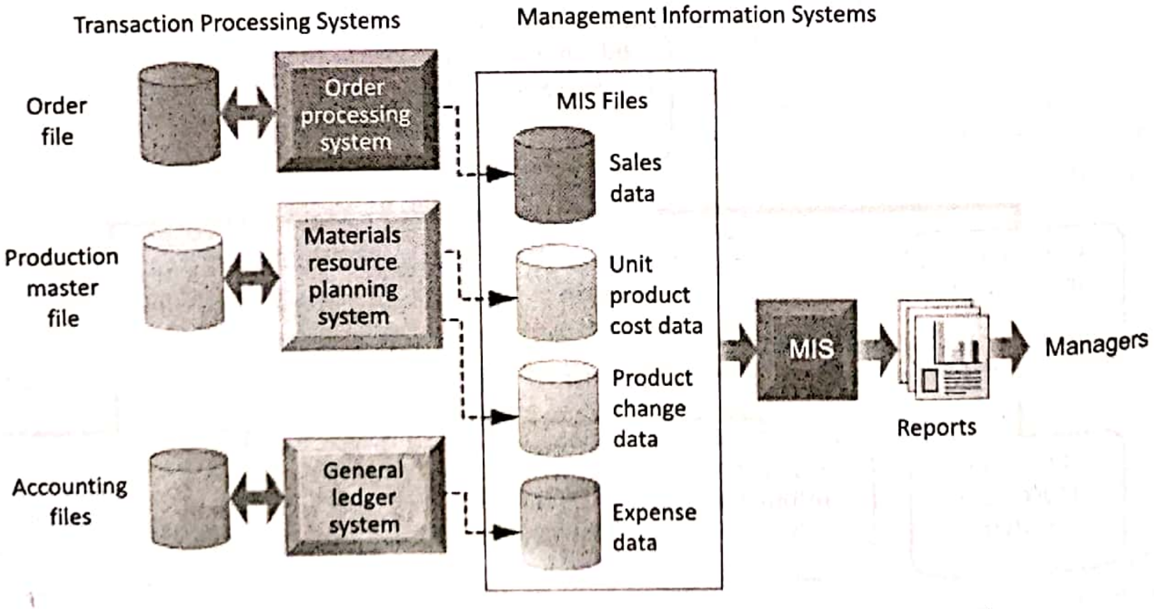


Figure: Working of Management Information Systems (MIS)

Computerized MIS typically extract and summarize data from TPS to allow managers to monitor and direct the organization. MIS can also provide employees accurate feedback about easily measured aspects of their work. The same data could be summarized in measure of performance, such as total sales for each type of item, for each salesperson and for each hour of the day.

Executive Supports Systems (ESS)

Senior managers use **executive support systems (ESS)** to help them make decisions. ESS serve the strategic level of the organization. They address non routine decisions requiring judgment, evaluation, and insight because there is no agreed-on procedure for arriving at a solution.

Specialised Information Systems

Specialised information systems are of various kinds such as GIS, Expert systems, Knowledge management systems, etc.

Geographical Information Systems (GIS)

A computer system is capable of assembling, storing, manipulating and displaying geographically referenced information that is data identified according to its location. This topic discussed in detail in separate chapter i.e. Geospatial Technology.

Knowledge Management Systems (KMS)

Knowledge management systems organize and dissect knowledge and then redistribute or share it with individuals of an organization. The purpose of these information systems is to bring innovation, improve performance, bring integration and retain knowledge within the organization. Although KMS are typically marketed to larger enterprises, small businesses can also benefit from harvesting knowledge. KMS serve as a central repository and retain information in a standard format. These systems can help business owners maintain consistency and enable speedy responses to customer inquiries.

Classification of Information Systems by Organisational Hierarchy

Organizations can also be divided into strategic, management, and operational levels and into four major functional areas: sales and marketing, manufacturing and production, finance and accounting, and human resources. Information systems serve each of these levels and functions.

Figure below shows the specific types of information systems that correspond to each organizational level and functional area. The organization has executive support systems (ESS) at the strategic level; management information systems (MIS) and decision-support systems (DSS) at the management level; and transaction processing systems (TPS) at the operational level. Systems at each level in turn are specialized to serve each of the major functional areas. Thus, the typical systems found in organizations are designed to assist workers or managers at each level and in the functions of sales and marketing, manufacturing and production, finance and accounting, and human resources.

The various types of systems in the organization have interdependencies. TPS are major producers of information that is required by the other systems, which, in turn, produce information for other systems.

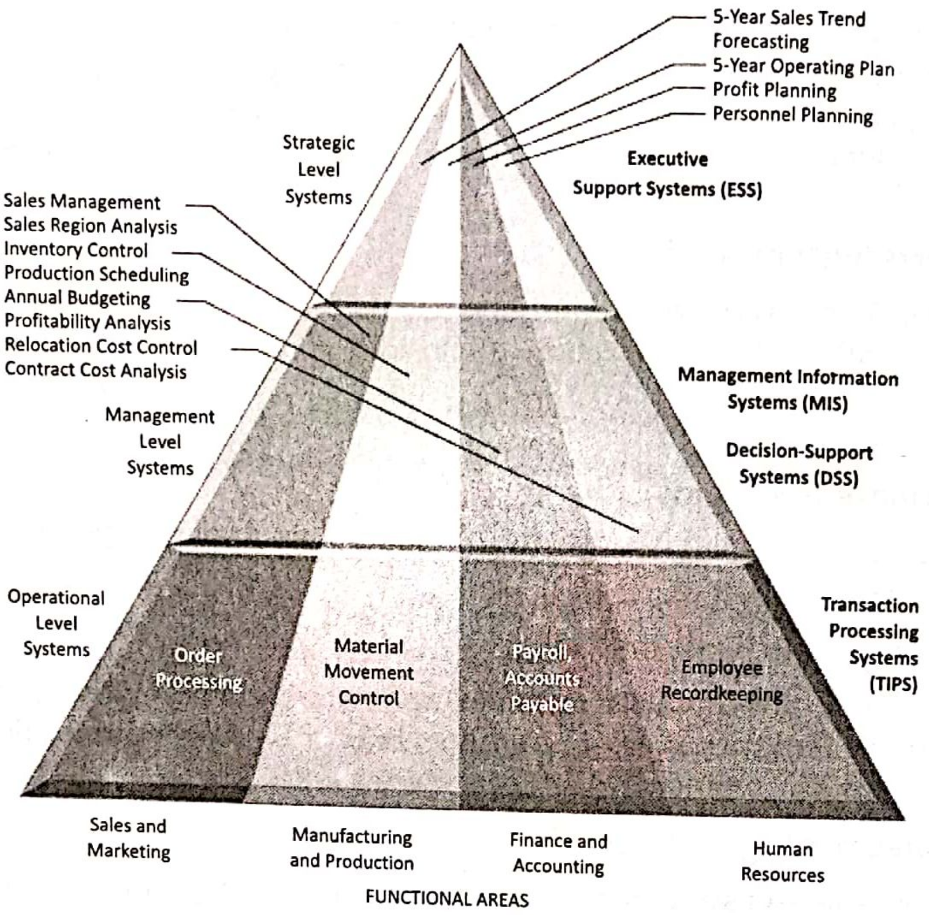


Figure: Classification of Information systems on the basis of Organisational Hierarchy

SURVEILLANCE

Surveillance is the monitoring of the behaviour, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them. This can include observation from a distance by means of electronic equipment (such as CCTV cameras), or interception of electronically transmitted information (such as Internet traffic or phone calls); and it can include simple, relatively no- or low-technology methods such as human intelligence agents and postal interception. The word surveillance comes from a French phrase for "watching over" ("sur" means "from above" and "veiller" means "to watch).

Surveillance is used by governments for intelligence gathering, the prevention of crime, the protection of a process, person, group or object, or for the investigation of crime. It is also used by criminal organizations to plan and commit crimes such as robbery and kidnapping, by businesses to gather intelligence, and by private investigators.

Surveillance is often a violation of privacy, and is opposed by various civil liberties groups and activists. Liberal democracies have laws which restrict domestic government and private use of surveillance, usually limiting it to circumstances where public safety is at risk. Authoritarian government seldom have any domestic restrictions; and international espionage is common among all types of countries. While there are several types of technologies that can be used to perform communications surveillance, we will focus on four categories: internet monitoring, mobile phone monitoring, fixed line interception, and intrusion technology.

Internet Monitoring: Internet monitoring is the act of capturing data as it travels across the internet toward its intended destination. It can take place across any point of the physical or electronic systems that comprise the internet.

Mobile Phone Monitoring: Mobile phone monitoring technologies capture information transmitted over mobile networks.

Fixed Line Interception: Fixed line interception entails the capture of information as it travels across public switched telephony networks (PSTN), which forms the backbone of our international communication networks. Modern surveillance technologies of PSTN fundamentally operate in such a way that a physical probe is placed on the phone network which allows for the interception of phone calls.

Intrusion Technology: Intrusion technologies clandestinely deploy malicious software (malware) on mobile phones and computers. The malware, or Trojan, allows operators to take complete control over the target's device by embedding itself in all system functions. Intrusion technologies are some of the most invasive forms of surveillance available. The user's device becomes spy in itself, capturing information around the individual including conversations with others and monitoring his or her online and offline activities.

INFORMATION TECHNOLOGY (MCQS)

Note: **Answers are bold and underlined.**

1. **Bandwidth is a data which a person can send through a network or modem connection. How it is usually measured?**
   (a) **In bits per second** (b) In megahertz (c) In Ohm (d) In watts
2. **What is BASIC (Beginners All-purpose Symbolic Instruction Code)?**
   (a) **A programming language** (b) A software
   (c) Software coding (d) A diploma course
3. **Which of the following is a conventional basic designation of pre-released software?**
   (a) Alpha (b) Omega (c) Raw (d) **Beta**
4. **Name the binary digit that is the smallest unit of digital information, either on or off, 1 or 0.**
   (a) Bitmap (b) **Bit** (c) Bit/second (d) Byte
5. **What is the name of that pre-installed programme on PCs that computer uses to start up (this programme checks all hardware connections and locates all devices during boot-up process)?**
   (a) BIOS (b) **Operating System** (c) BASIC (d) JAVA
6. **What does mean by BIOS?**
   (a) **Basic Input/output system** (b) Beginning Input/output system
   (c) Basic Ingoing/outgoing system (d) Basic In/out system

7. What does mean by Browse?

(a) To view data in a database or online system.

(b) To search through and access database material without permission.

(c) Both of these (d) None of these

8. Term the amount of memory that is needed to specify one character, eight bits?

(a) Bit (b) Kilo byte (c) Byte (d) Mega byte

9. There are many different types of caches, pronounced like cash, in computer but they all serve the same purpose. What is their function?

(a) To store data. (b) To store software.

(c) To store memory.

(d) To store recently-used information in place where it can be accessed extremely fast.

10. Which of the following is used metaphorically to describe the virtual world of computers?

(a) Cyber world (b) Cyberspace (c) Virtual world (d) Virtual space

11. What is called a structured set of data that is normally associated with software to access and manipulate that data?

(a) Database (b) Backup (c) Storage (d) Hard disk

12. What is termed the portion of RAM set aside for temporarily holding information read from a disk?

(a) ROM (b) Cache memory (c) Bus (d) Disk Cache

13. There is a small file that helps the computer to communicate with certain hardware devices. What this file is called?

(a) Software (b) Application (c) Driver (d) Control

14. Name the high-capacity optical disc that looks like a CD, but can store much information than CD?

(a) CD-Rome (b) Module

(c) DRAM (d) Digital Versatile Disc (DVD)

15. Internet is a worldwide collection of interconnected networks which provide a wide variety of services. Mention the network protocols used by internet.

(a) TCP network protocols (b) IP network protocols

(c) TCP/IP network protocols (d) Firewall network protocols

16. Name an internal or private internet that is used strictly within the confines of a company, university, etc.

(a) Home net (b) Ethernet (c) Net (d) Intranet

17. What is called the memory that can be used by applications to perform necessary tasks while the computer is on?

(a) Soft memory (b) Random Access Memory (RAM)

(c) Hard memory (d) Volatile memory

18. One kilobyte = ____ bytes.

(a) 1250 (b) 2088 (c) 1024 (d) 1000

19. **Who is the father of computer?**
(a) Bill Gates (b) Microsoft (c) Charles Babbage (d) Steve

20. **All of the following are examples of input devices EXCEPT a:**
(a) Scanner (b) Mouse (c) Keyboard (d) Printer

21. **Which of the following is an example of an input device?**
(a) Scanner (b) Speaker (c) CD (d) Printer

22. **What is artificial intelligence?**
(a) Putting your intelligence into computer.
(b) Programming with your own intelligence.
(c) Making a machine intelligent. (d) Playing a Game.

23. **What is the term used for describing the judgmental or common-sense part of problem solving?**
(a) Heuristic (b) Critical (c) Value based (d) Analytical

24. **Strong AI is:**
(a) The embodiment of human intellectual capabilities within a computer.
(b) A set of computer programmes that produce output that would be consider to reflect intelligence in it were generated by humans.
(c) The study of mental faculties through the use of mental models implemented on a computer.
(d) All of these.

25. **Weak AI is:**
(a) The embodiment of human intellectual capabilities within a computer.
(b) A set of computer programs that produce output that would be consider to reflect intelligence if it were generated by humans.
(c) The study of mental faculties through the use of mental models implemented on a computer.
(d) All of these.

26. **__________ is called the father of AI.**
(a) James C Gosling (b) Dennis Ritchie
(c) Alan Turing (d) John Mcarthy

27. **Transmission media are usually categorized as _______.**
(a) Fixed or unfixed (b) Guided or unguided
(c) Determinate or indeterminate (d) Metallic or nonmetallic

28. **Which of the following is primary memory?**
(a) Random Access Memory (b) Read only Memory
(c) Serial Access Memory (d) None of these

29. **_____ cable consists of an inner copper core and conducting outer sheath.**
(a) Twisted-pair (b) Coaxial

(c) Fibre-optic (d) Shielded twisted-pair

30. In fibre optics, the signal travels through______ waves.

(a) Light (b) Radio
(c) Infrared (d) Very low-frequency

31. Which of the following primarily uses guided media?

(a) Cellular telephone system (b) Local telephone system
(c) Satellite communications (d) Radio broadcasting

32. In an optical fibre the inner core is ______ the cladding.

(a) Denser than (b) Less dense than
(c) The same density as (d) another name for

33. The inner core of an optical fibre is ______ in composition.

(a) Glass or plastic (b) Copper (c) Bimetallic (d) Liquid

34. When a beam of light travels through media of two different densities, if the angle of incidence is greater than the critical angle, ______ occurs.

(a) Reflection (b) Refraction (c) Incidence (d) Criticism

35. ______ cables carry data signals in the form of light.

(a) Coaxial (b) Fibre-optic (c) Twisted-pair (d) None of these

36. ______ media transport electromagnetic waves without the use of a physical conductor.

(a) Guided (b) Unguided (c) Either (a) or (b) (d) None of these

37. ______ are used for cellular phone, satellite, and wireless LAN communications.

(a) Radio waves (b) Microwaves (c) Infrared waves (d) None of these

38. ______ are used for short-range communications such as those between a PC and a peripheral device.

(a) Radio waves (b) Microwaves (c) Infrared waves (d) None of these

39. Which topology requires a central controller or hub?

(a) Mesh (b) Star (c) Bus (d) Ring

40. Which topology requires a multipoint connection?

(a) Mesh (b) Star (c) Bus (d) Ring

41. ______ refers to the physical or logical arrangement of a network.

(a) Data flow (b) Mode of operation (c) Topology (d) None of these

42. A ______ is a data communication system within a building, plant, or campus, or between nearby buildings.

(a) MAN (b) LAN (c) WAN (d) None of these

43. A ______ is a data communication system spanning states, countries, or the whole world.

(a) MAN (b) LAN (c) WAN (d) None of these

44. ______ is a collection of many separate networks.

(a) A WAN (b) An internet (c) A LAN (d) None of these

45. **A ________ is a set of rules that governs data communication.**

(a) Forum (b) Protocol

(c) Standard (d) None of these

46. **Which of the following systems analyzes spatial information?**

(a) Neural network (b) Genetic algorithm

(c) Intelligent agent (d) Geographical information system

47. **Which of the following represents one billion characters?**

(a) Byte (b) Gigabyte (c) Kilobyte (d) Megabyte

(e) Terabyte

48. **Which of the following represents the fastest data transmission speed?**

(a) Bandwidth (b) Mbps (c) Gbps (d) Kbps

49. **Which of the following domains is used by for profit businesses?**

(a) .com (b) .edu (c) .mil (d) .net

50. **What is the name for a webpage address?**

(a) Directory (b) Domain (c) Extension (d) Protocol

CHAPTER 14

ENERGY

Energy is the capacity of a system to do work. Energy causes things to happen around us. During the day, the sun gives out light and heat energy. At night, street lamps use electrical energy to light our way. When a car drives by, it is being powered by gasoline, a type of stored energy. The food we eat contains energy. We use that energy to work and play.

Energy exists in many different forms. Examples of these are: light energy, heat energy, mechanical energy, gravitational energy, electrical energy, sound energy, chemical energy, nuclear or atomic energy and so on. These forms of energy can be transferred and transformed between one another. This is of immense benefit to us. For a source of energy to end up as electricity it may undergo many transformations before it can power the light bulb in homes.

Although there are many specific types of energy, the two major forms are Kinetic Energy and Potential Energy.

Kinetic Energy

It is a matter of common experience that a fast moving stone can break a windowpane, falling water can rotate turbines, and moving air can rotate windmills and propel sailboats. In all these examples, the moving body possesses energy. Work is done by the body in motion. This type of energy possessed by moving objects is known as kinetic energy. Kinetic energy is defined as *the energy possessed by an object by virtue of its motion*.

The magnitude of the kinetic energy depends on both the mass and the velocity of the object according to the equation $K.E. = \frac{1}{2}mv^2$ where m is the mass of the object and v is its velocity.

Potential Energy

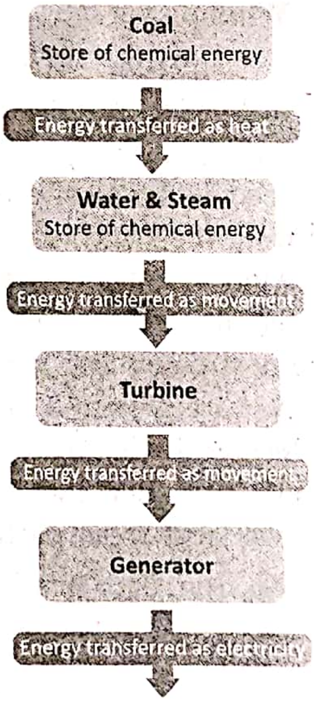
Water stored in a reservoir is capable of rotating turbines, which are kept at a lower level, i.e. water stored in a reservoir possesses energy. A toy car driven by a winding key. When we turn the key the spring gets wound and if we leave the toy car on the floor, it starts moving due to the unwinding of the spring. This means that the wound spring possesses energy, which in turn moves the toy car. Here the gain in energy is due to its position or condition. *Energy by virtue of position or configuration is called potential energy*. Formula of potential energy is P.E. = mgh where m is mass, g is gravitational acceleration and h denotes height.

There are many forms of energy, but they can all be put into two categories: Potential energy and Kinetic energy.

Potential Energy Potential energy is stored energy. There are several forms of potential energy.	**Kinetic Energy** Kinetic energy is the motion of waves, electrons, atoms, molecules, substances, and objects.
Chemical Energy is the energy stored in the bonds of atoms and molecules. Batteries, biomass, petroleum, natural gas and coal are examples of stored chemical energy. Chemical energy is converted to thermal energy when we burn wood in a fireplace or burn gasoline in a car's engine.	**Light Energy** is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, X-rays, gamma rays and radio waves. Light is one type of radiant energy. Sunshine is radiant energy, which provides the fuel and warmth that make life on earth possible.
Nuclear Energy is the energy stored in the nucleus of an atom — the energy that holds the nucleus together. Very large amounts of energy can be released when the nuclei are combined or split apart.	**Thermal Energy** or heat is the vibration and movement of the atoms and molecules within substances. As an object is heated up, its atoms and molecules move and collide faster. Geothermal energy is the thermal energy in the earth.
Gravitational Energy is a form of energy that is stored in an object's height. The higher and heavier the object, the more gravitational energy is stored. Hydropower is example of gravitational energy, where the dam "piles" up water from a river into a reservoir.	**Sound** is the movement of energy through substances in longitudinal (compression/ rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate. The energy is transferred through the substance in a wave.
Mechanical Energy is the energy stored in objects by tension. Compressed springs and stretched rubber bands are examples of stored mechanical energy.	**Electrical Energy** is delivered by tiny charged particles called electrons, typically moving through a wire.

ENERGY SOURCES

The energy sources have been split into two categories: *Non-renewable sources* and *renewable sources*.


Coal
Store of chemical energy
Energy transferred as heat
Water & Steam
Store of chemical energy
Energy transferred as movement
Turbine
Energy transferred as movement
Generator
Energy transferred as electricity

Non-Renewable Energy Sources

Non-renewable energy comes from sources that will run out and cannot be produced on a scale comparable to its consumption. Most non-renewable energy sources are fossil fuels: coal, petroleum, and natural gas. Carbon is the main element in fossil fuels.

Coal

About 300 million years ago, enormous ferns and other prehistoric plants were common on the swamp-like earth. When those plants died and fell to the ground, they were covered with silt, day and water and they slowly decomposed. As decomposition took place in the absence of oxygen, much of the hydrogen content of the matter was eroded away, leaving a material rich in carbon. The material was compressed over the years by sand and dirt, leaving the form of carbon known as coal.

There are various types of coal. The nature of coal is such that the higher the carbon content, the more cleanly and brilliantly the coal burns. The states of coal, from lowest carbon content to highest, are peat, lignite, bituminous coal, and anthracite coal. If the coal is heated and compressed even more, the result is "graphite," almost completely pure carbon. Nearly all the different forms of coal are used in some way or another. For instance, peat has been used for burning in furnaces, whereas bituminous coal is used extensively for the generation of electricity.

Petroleum

Petroleum, or "crude oil," is a liquid fuel that is present in various locations throughout the world. It has many uses, from the generation of electricity to the manufacture of medicines, plastics, and other commercial items. Much like coal, petroleum is formed from the remains of biodegraded organic material. When animals that lived in the sea millions of years ago died underwater, their remains were gradually covered by layers of very fine dirt known as "silt" on the ocean floor. Then, as the years passed, pressure from the layers built up and compressed the organic material, forming the oil.

Natural Gas

Natural gas is almost always found in deposits of petroleum. When the petroleum is drilled, natural gas is also recovered. Wells with only natural gas also exist. Once the natural gas is recovered, other fuels are extracted by processes called condensation or absorption. The remaining gas is piped directly for commercial and residential applications.

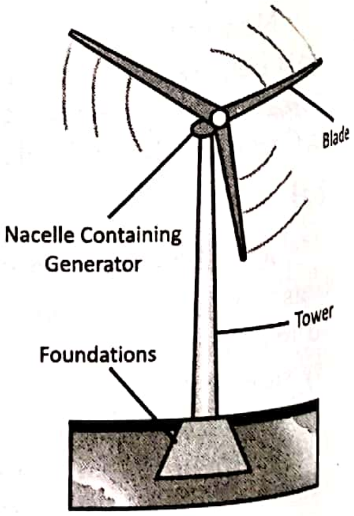
The western hemisphere, Europe, and parts of Africa contain the largest natural gas deposits. The gas is usually transported by pipelines. Compared to petroleum and coal, natural gas is relatively clean-burning. Because it contains only trace portions of sulphur and nitrogen, emissions of the harmful by products associated with combustion of other fossil fuels are minimal.

Renewable Energy Sources

Renewable energy is generally defined as energy that is collected from resources which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Let us now discuss renewable energy sources in detail.

Wind power

Airflows can be used to run wind turbines. Modern utility-scale wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5-3 MW have become the most common for commercial use; the power available from the wind is a function of the cube of the wind speed, so as wind speed increases, power output increases dramatically up to the maximum output for the particular turbine. Areas where winds are stronger and more constant, such as offshore and high altitude sites are preferred locations for wind farms. Globally, the long-term technical potential of wind energy is believed to be 40 times current electricity demand. This could require wind turbines to be installed over large areas, particularly in areas of higher wind resources.



Hydropower

Energy in water can be harnessed and used. Since water is about 800 times denser than air, even a slow flowing stream of water, or moderate sea swell, can yield considerable amounts of energy. There are many forms of Hydel energy.

- Hydroelectric energy is a term usually reserved for large-scale hydroelectric dams. Examples are Tarbela dam and Mangla dam.
- Micro hydro systems are hydroelectric power installations that typically produce up to 100 kW of power. They are often used in water rich areas as a remote-area power supply.
- Run-of-the-river hydroelectricity systems derive kinetic energy from rivers and oceans without the creation of a large reservoir.
- Tidal power, also called tidal energy, is a form of hydropower that converts the energy of tides into useful forms of power — mainly electricity. Although not yet widely used, tidal power has potential for future electricity generation.

Solar Energy

Solar energy applies energy from the sun in the form of solar radiation for heat or to generate electricity. Solar-powered electricity generation uses either photovoltaic's or heat engines (concentrated solar power). A partial list of other solar applications includes space heating and cooling through solar architecture, day lighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes.

Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favourable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

Biomass and Biofuels

Biomass is biological material derived from living, or recently living organisms. In the context of biomass for energy this is often used to mean plant based material, but biomass can equally apply to both animal and vegetable derived material.

There are a number of technological options available to make use of a wide variety of biomass types as a renewable energy source. Conversion technologies may release the energy directly, in the form of heat or electricity, or may convert it to another form, such as liquid biofuel or combustible biogas. Today, new ways of using biomass are still being discovered.

Geothermal Energy

Hot water and steam from deep underground can be used to drive turbines: this is called geothermal energy. Several types of rock contain radioactive substances such as uranium. Radioactive decay of these substances releases heat energy, which warms up the rocks. In volcanic areas, the rocks may heat water so that it rises to the surface naturally as hot water and steam. Here the steam can be used to drive turbines and electricity generators.

In some places, the rocks are hot, but no hot water or steam rises to the surface. In this situation, deep wells can be drilled down to the hot rocks and cold water pumped down. The water runs through fractures in the rocks and is heated up. It returns to the surface as hot water and steam, where its energy can be used to drive turbines and electricity generators.

Importance of Renewable Energy

There are several important reasons that make renewable energy extremely important for the future of our society. Renewable energy still has a long way to go in order to replace fossil fuels and become primary source of energy consumption but things have been lately definitely moving in the right direction. But let us focus here about the future impact of renewable energy on our society.

Positive environmental impact is certainly one of the most important reasons. Fossil fuels when burn, create harmful greenhouse gas emissions and our planet is already feeling the impact of climate change. By using renewable energy instead of fossil fuels we would significantly decrease the current levels of greenhouse gas emissions, and this would have positive environmental impact for our entire planet.

Renewable energy can improve our energy security by reducing the need for foreign oil import. The global oil market has been characterized by extremely volatile prices and our dependence on oil continues to grow. By switching to renewable energy and using more domestic renewable energy sources instead of importing foreign oil we would drastically improve our energy security and energy independence.

Alternative Energy

Alternative energy source is any source of energy that does not belong to traditional energy sources. Traditional energy sources are fossil fuels (coal, oil and natural gas). Some dictionaries, like for instance, Oxford dictionary puts alternative energy sources in correlation to environment by stating that term “alternative energy sources” refers to energy derived from sources that do not use up natural resources or harm the environment. The most common alternative energy sources are: solar energy, wind energy and geothermal energy. Other alternative energy sources include bio-fuels, tidal, wave power, and hydrogen.

ENERGY CONSERVATION

Energy conservation is any behaviour that results in the use of less energy. Energy conservation is important from many different perspectives and not just because saving energy means saving our money by lowering our monthly energy bills (the economic importance of energy conservation). Energy conservation methods are also extremely important from the environmental point of view because we are still heavily dependent on fossil fuels, and by reducing our energy needs we are also reducing the global level of greenhouse gas emissions that contribute to climate change and global warming.

Energy efficiency is not energy conservation.

Energy conservation is reducing or going without a service to save energy. For example: Turning off a light is energy conservation. Replacing an incandescent lamp with a compact fluorescent lamp (which uses much less energy to produce the same amount of light) is energy efficiency. Energy efficiency is "using less energy to provide the same service".

To conserve energy everyone will have to play his/her role. Major sectors that use electricity are industry, transport, commercial and domestic sector. All these sectors will have to fulfil their duties. Here are the guidelines.

1. **Install Compact Fluorescent Lights:** Try replacing incandescent bulbs in your home with Compact Fluorescent Lights. Compact Fluorescent Lights cost more upfront but last 12 times longer than regular incandescent bulbs. CFL will not only save energy but over time you end up saving money.
2. **Use Maximum Daylight:** Turn off lights during the day and use daylight as much as possible. This will reduce the burden on the local power grid and save you good amount of money in the long run.
3. **Get Energy Audit Done:** Getting energy audit done by hiring an energy audit expert for office buildings, commercial plaza, homes and industries is an energy conservation technique that can help you conserve energy and save good amount of money every month. Energy audit is nothing but a process that helps you to identify areas where it is losing energy and what steps you can take to overcome them
4. **Use Energy Efficient Appliances:** When planning to buy some electrical appliances, prefer to buy one with Energy Star rating. Energy efficient appliances with Energy Star rating consume less energy and save you money. They might cost you more in the beginning but it is much more of an investment for you.
5. **Drive Less, Walk More and Carpooling:** Yet another energy conservation technique is to drive less and walk more. This will not only reduce your carbon footprint but will also keep us healthy as walking is a good exercise. If your colleagues stay nearby, try doing carpooling with them. This will not only bring down your monthly bill you spend on fuel but will also make you socially more active.
6. **Switch off Appliances when Not in Use:** Electrical appliances like TV, idle printer, desktop computer keep on using electricity even when not in use. Just switch them off if you don't need them immediately.
7. **Plant Shady Landscaping:** Shady landscaping outside your home will protect it from intense heat during hot and sunny days and chilly winds during the winter season. This will keep your home cool during summer season and will eventually turn to big savings when you calculate the amount of energy saved at the end of the year.
8. **Education:** Education is probably the most powerful of the energy conservation techniques that can be used. Education is about more than teaching people the importance of conservation, it is about showing the alternative choices that can be used in construction, manufacturing and other processes.
9. **Alternative Power:** There are more processes that are starting to use alternative power and fuel sources in many different areas of life. The use of alternative power is one of the most key energy conservation techniques because almost all of the transition models require that the existing processes be upgraded or replaced to more energy efficient models too.
10. **Reduced Demand:** There are numerous initiatives that are working to reduce the overall demand on the energy resources of the world. This can range everywhere from education programs to changing the type of required insulation in new construction.

11. **Research & Development:** Continued funding of research and development projects in the energy conservation field is how we discover the changes that can be made to reduce consumption and discover renewable methods to provide us with the energy that modern life requires.

BIOFUELS

Bioenergy is energy derived from biofuels. Biofuels are fuels produced directly or indirectly from organic material – biomass – including plant materials and animal waste. Overall, bioenergy covers approximately 10% of the total world energy demand. Traditional unprocessed biomass such as fuelwood, charcoal and animal dung accounts for most of this and represents the main source of energy for a large number of people in developing countries who use it mainly for cooking and heating.

More advanced and efficient conversion technologies now allow the extraction of biofuels from materials such as wood, crops and waste material. Biofuels can be solid, gaseous or liquid, even though the term is often used in the literature in a narrow sense to refer only to liquid biofuels for transport. Biofuels may be derived from agricultural crops, including conventional food plants or from special energy crops. Biofuels may also be derived from forestry, agricultural or fishery products or municipal wastes, as well as from agro-industry, food industry and food service by-products and wastes.

A distinction is made between primary and secondary biofuels. In the case of primary biofuels, such as fuelwood, wood chips and pellets, organic materials are used in an unprocessed form, primarily for heating, cooking or electricity production. Secondary biofuels result from processing of biomass and include liquid biofuels such as ethanol and biodiesel that can be used in vehicles and industrial processes. Bioenergy is mainly used in homes (80%), to a lesser extent in industry (18%), while liquid biofuels for transport still play a limited role (2%).

Biomass Feedstocks

Every region has its own locally generated biomass feedstocks from agriculture, forest, and urban sources. Some of the most common (and/or most promising) biomass feedstocks are:

- **Grains and starch crops** – sugar cane, corn, wheat, sugar beets, sweet potatoes, etc.
- **Agricultural residues** – Corn stover, wheat straw, rice straw, orchard prunings, etc.
- **Food waste** – waste produce, food processing waste, etc.
- **Forestry materials** – Logging residues, forest thinnings, etc.
- **Animal byproducts** – Tallow, fish oil, manure, etc.
- **Energy crops** – Switchgrass, hybrid poplar, willow, algae, etc.
- **Urban and suburban wastes** – municipal solid wastes (MSW), lawn wastes, wastewater treatment sludge, urban wood wastes, waste cooking oil, etc.

Generations of Biofuels

On the basis of feedstock there are four generations of biofuels.

First Generation: First generation biofuels refer to fuel derived from food crops like Sugar cane, Soybeans, Sugar beat, corn, animal fats and vegetable oil.

Second Generation: Second generation biofuels are only made from lignocellulosic crops. Lignocellulosic crops are mainly hard, woody crops. A big problem with the first generation of biofuels is that it uses food crops. This caused the price of food to go up due to the high demand of food crops and caused many issues.

Third Generation: Algal fuel is the third generation of biofuels. According to US Department of Energy, algal oil can yield up to 30 times more energy per acre than land crops like soybeans. Algae can be used to produce bioethanol, bio methanol, bio butanol, biodiesel, and other biofuels.

Fourth Generation: Fourth generation biofuels are crops that are genetically engineered to consume more CO_2 from the atmosphere than they will produce during combustion later as a fuel.

Types of Biofuels

The most widely used liquid biofuels for transport are ethanol and biodiesel and the gaseous biofuel in biogas.

BioEthanol is a type of alcohol that can be produced using any feedstock containing significant amounts of sugar, such as sugar cane or sugar beet, or starch, such as maize and wheat. Sugar can be directly fermented to alcohol, while starch first needs to be converted to sugar. The fermentation process is similar to that used to make wine or beer, and pure ethanol is obtained by distillation. The main producers of bioethanol are Brazil and the USA.

Ethanol can be blended with petrol or burned in nearly pure form in slightly modified spark-ignition engines. A litre of ethanol contains approximately two thirds of the energy provided by a litre of petrol. However, when mixed with petrol, it improves the combustion performance and lowers the emissions of carbon monoxide and sulphur dioxide.

Biodiesel is produced, mainly in the European Union, by combining vegetable oil or animal fat with an alcohol. Biodiesel can be blended with traditional diesel fuel or burned in its pure form in compression ignition engines. Its energy content is somewhat less than that of diesel (88 to 95%). Biodiesel can be derived from a wide range of oils, including rapeseed, soybean, palm, coconut or Jatropha oils and therefore the resulting fuels can display a greater variety of physical properties than ethanol. Biodiesel is produced through the process of esterification.

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source and in many cases produces a very small carbon dioxide and other gases.

Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials. Biogas is a clean and efficient fuel. It is a mixture of methane (CH_4), carbon dioxide (CO_2), hydrogen (H_2) and hydrogen sulphide (H_2S). The chief constituent of biogas is methane and can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy into electricity and heat.

Biogas Production

In the standard process of **biogas production**, the biomass material is processed before being fed into the biogas plant. The plant consists of a mixer, a digester and a gas storage tank.

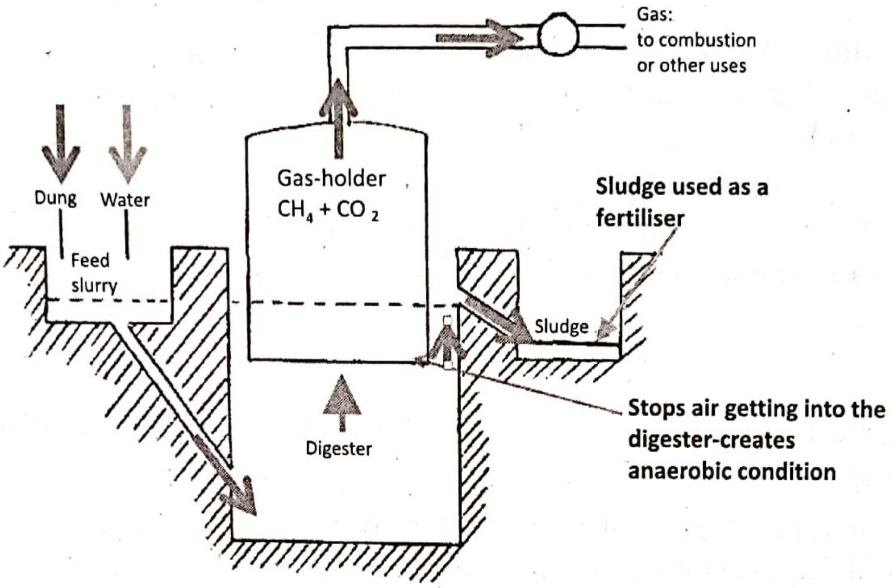

Gas:
to combustion
or other uses
Dung
Water
Feed
slurry
Gas-holder
CH₄ + CO₂
Digester
Sludge used as a fertiliser
Sludge
Stops air getting into the digester-creates anaerobic condition

Figure: Biogas Production Process

The digester is also called fermentation tank and is the crucial component of the plant since it provide the anaerobe conditions in which the bacteria generate biogas. The substrates have to be constantly heated and stirred in order to ensure their homogeneity and the consistent discharge of gas. The gas holder is normally an airproof steel container that, by floating like a ball on the fermentation mix, cuts off air to the digesters and collects the gas generated. The gas holder is equipped with a gas outlet, while the digesters are provided with an overflow pipe to lead the sludge out into a drainage pit. The gas collected is purified and compressed to store for further use.

Advantages of Biofuels

Renewable Resource: Most of the fossil fuels will end up in near future. Since most of the sources like manure, corn, sugarcane, soybeans, waste from crops and plants are renewable and are not likely to run out any time soon.

Reduce Greenhouse Gases: Fossil fuels, when burnt, produce large amount of greenhouse gases. To reduce the impact of greenhouse gases, people around the world are using biofuels. Studies suggests that biofuels reduces greenhouse gases up to 65%.

Easy adoption and economical: Biofuels are adaptable to current engine designs and perform very well in most conditions. This keeps the engine running for longer, requires less maintenance and brings down overall pollution check costs. With the increased demand of biofuels, they have a potential of becoming cheaper in future as well.

Economic Security: Not every country has large reserves of crude oil. For them, having to import the oil puts a huge dent in the economy. If more people start shifting towards biofuels, a country can reduce its dependence on fossil fuels. More jobs will be created with a growing biofuel industry, which will keep economy secure.

Reduce Dependence on Foreign Oil: As prices of crude oil are rising, we need some more alternative energy solutions to reduce our dependence on fossil fuels. Biofuels reduces the demand of oil and the price of oil.

Disadvantages of Biofuels

High Use of Fertilizers: Biofuels are produced from crops and these crops need fertilizers to grow better. The downside of using fertilizers is that they can have harmful effects on surrounding environment and may cause water pollution.

Shortage of Food: Biofuels are extracted from plants and crops that have high levels of sugar in them. However, most of these crops are also used as food crops. It will take up agricultural space from other crops, which can create a number of problems. One major worry being faced by people is that the growing use of biofuels may just mean shortage of food and rise in food prices as well.

Industrial Pollution: Large scale industries meant for churning out biofuel are known to emit large amounts of emissions and cause small will scale air and water pollution as well.

High Water Use: Large quantities of water are required to irrigate the biofuel crops and it may cause pressure on local and regional water resources, if not managed wisely.

Future Rise in Price: Current technology being employed for the production of biofuels is not as efficient as it should be. Scientists are engaged in developing better means by which we can extract this fuel. However, the cost of research and future installation means that the price of biofuels may see a significant spike.

More energy is required for producing biofuels than they can generate: Researchers has concluded that producing ethanol from corn requires 29% more energy than the end product itself is capable of generating.

High transition cost from gasoline to biofuels: Shifting from gasoline to biofuels, given the number of gas — only cars already on the road and the lack of ethanol or biodiesel pumps at existing filling stations — would take some time.

Soil degradation and deforestation: With the increase in demand for alternative energy sources, demand for agricultural land could increase. Increase demand for biofuel derived from cash crops such as sugarcane, sugar beet, maize and sorghum would result in major changes to current land uses and can lead to deforestation.

ENERGY CRISIS IN PAKISTAN

Essay courtesy: Syed Nasir Jamal Shah (IRS)

Outline

Introduction:

Energy crisis is a matter of serious concern in Pakistan

Causes

- Poor policies of government
- Lack of consensus among politicians to build new dams
- Scarcity of required funds to launch new power projects
- Less use of modern technology
- Flaws in regulation and distribution of electricity
- Misuse of energy by common man

- Failure to exploit national resources
- Weak role of media

Effects

- Excessive load shedding
- Economic downfall
- Unemployment and poverty
- Psychological problems in people
- Gap between state and public
- Declining exports

Suggestions

- Consensus among politicians
- New dams
- Proper use of national resources and modern technology
- Reforms in regulation and distribution of electricity
- Far-sightedness of government
- Active role of media
- Population control

Conclusion

ENERGY CRISIS IN PAKISTAN

Energy crisis is a matter of serious concern in Pakistan. It is worsening day by day. Energy crisis is an international issue. Several countries are facing this problem but Pakistan is witnessing an unprecedented crisis of energy. It has given a severe setback to the country's economy. It has badly disturbed the socio-economic fabric of Pakistani society. It has added to the miseries of people. Previous governments did not pay heed to this issue. Adequate steps were not taken to boost up energy sector in last dictator's nine-year rule. Same was the case with last democratic government. Increasing needs for electricity were not considered. It is need of the hour to address this issue. If the problem is tackled properly, the situation can be reversed. Solution to this problem can result in rapid economic growth. Social, cultural as well as educational development of Pakistan is linked with the eradication of its energy woes. On the contrary, if the problem is not given due attention, it will further aggravate the situation. Resultantly, prevalent darkness will become the fate of the country. Then, there will be no use of crying over spilt milk.

As every problem has some causes, poor policies of previous governments are the major cause of this crisis. Present government is not taking concrete steps to tackle the issue. Usage of energy is increasing day by day but production of energy is not as per requirement. The government has failed to keep pace with growing needs of energy. It did not take initiatives in order to add to the national energy pool. It appears that increase in the production of energy is excluded from priorities of the government. Ultimately, this ignorance along with the poor policies results in energy crisis in Pakistan.

In addition to this, lack of consensus among politicians in order to build new dams is also one of the prime reasons of energy crisis in the country. Our politicians lack unity. They are badly ivided pertaining to this issue. Everyone wants to secure his vested interests. Such kind of ersonalization leads towards disunity. Kalabagh Dam is the best example in this regard. A few arliamentarians say that this dam cannot be built until they are alive. Construction of this dam an minimize energy crisis as well as check flood destruction that appears every year. Building ew dams is a viable solution but political wrangling is standing in the way of this process.

Besides political disunity, scarcity of required funds is also adding insult to injury. Economic condition of the country is not up to the mark. Required funds are not available to launch new projects. Budget deficit does not allow the construction of new dams. Few big and several small dams and reservoirs are needed to address energy crisis properly. Lack of funds is an impediment in the way of achieving our goals.

Furthermore, less use of modern technology is also contributing a lot to this problem. It is clear before everyone with even a modicum of knowledge that modern technology has become a dire need for making progress nowadays. We are lagging behind in this field. Pakistanis are not using advanced technological tools in a proper way to get rid of energy crisis. We are not utilizing wind and solar energy properly. This improper use of modern technology is resulting in present crisis of energy in Pakistan.

Likewise, flaws in regulation and distribution of electricity are also fanning the flames of energy crisis in the country. Pakistan is already facing shortfall of electricity. Line losses and power theft are further aggravating the situation. All this is done because of the weak regulation and distribution policies of the government. Corrupt officers, linemen and metre readers abet general public in power theft. It results in economic loss to WAPDA which ultimately leads to this crisis.

Similarly, it is no secret that common man is misusing energy. Along with power theft, people also use electricity carelessly. They do not bother to turn off extra lights and fans. Electric bulbs are excessively used in shopping centres. Decorative lights on the occasions of marriages and other festivals have become a fashion nowadays. Unnecessary use of air-conditioners at homes, offices and marriage halls is causing energy crisis as well. Majority of Pakistanis use electricity in a careless manner which is the prime reason of this issue.

Likewise, failure to exploit national resources also results in energy crisis in Pakistan. Pakistan does not lack resources. It is the poor management which results in problems like energy crisis. Pakistan has several thousands of tons of coal in Thar. If this coal is used properly in production of energy, not only the present crisis can be solved but future of the country can also be secured from energy crisis. Our coal reserves are capable of producing energy for 50 years. Same is the case with wind and solar energy. Cholistan and Thar deserts are the most suitable places for solar power projects. Pakistan has natural resources in huge quantity but the ability to exploit them is lacking badly.

Last but not least, less investigative role of media is also adding fuel to fire. Media does not fully help WAPDA in pointing out power theft and corruption of government officers in this regard. Same is the case with spreading awareness among masses to save energy. Media has failed to convince people in order to lessen the careless use of electricity. Along with less vibrant use of media, industrialization and over population are also breeding energy crisis in Pakistan. Media is not playing its due role in highlighting the factors responsible for this problem in the country.

As each crisis has some effects, load shedding is one of the biggest effects of energy crisis. All the cities as well as villages of the country are in darkness. People do not have sufficient amount of electricity. It has disturbed socio-economic fabric of Pakistani society. Education of children is affected due to long hours power cuts in the country. Same is the case with treatment in hospital. Patients are facing difficulties because of energy crisis.

Similarly, economy of the country has received a severe setback owing to energy crisis. Industries are closed due to frequent power breakdown. Shopping has decreased. Shops are closed prior to the routine time. Factories are facing problems in the completion of their targets. This situation does not only affect the rich but the poor also face difficulties. Even tailors are unable to earn their livelihood according to their needs. The reason behind all this is energy crisis. Resultantly, economic sector of the country is damaged badly.

Moreover, energy crisis gives rise to unemployment and poverty. Energy crisis causes load shedding which leads to closure of industries. Consequently, there is no place for employees in factories. As unemployment and poverty are directly proportional to each other, poverty also increases in Pakistan. Almost 40% of total population is living below the poverty line in Pakistan as per recent estimates.

Furthermore, energy crisis has also affected people mentally and psychologically. Psychosocial problems among general public are increasing day by day. People have become habitual of electricity but now, they are facing unscheduled and frequent power breakdown. They are unable to sleep well. Neither they can get their clothes ironed nor do they reach their offices in time. This situation is resulting in mental dissatisfaction. People are facing problems in maintaining their routine lives due to prevalent energy crisis in the country.

In addition to this, gap between state and public has reached an alarming stage as a result of this issue. People have lost their trust in their rulers. They even use harsh words against them. Respect of politicians is minimum in the eyes of public. Frequent strikes and sit-ins are the evidences. Respect for leaders is rare in society.

Last but not least, our exports are affected badly. It has given a massive blow to the country's economy. It is the most dangerous impact of energy crisis in Pakistan. Deficiency in export is causing economic crisis as well. It is no secret that the situation is very appalling but with constant struggle and strong political will, it is still reversible. Some concrete steps are needed to be taken. Following viable remedial measures can help a lot in ameliorating the condition.

As every problem has some solutions, consensus among politicians to build new dams can do much in this regard. There must be unity among our rulers. Interests of the country should be considered more important than personal interests. Our politicians should develop consensus upon building of Kalabagh Dam as well as many other new dams. Dams have several benefits. They can produce electricity, irrigate barren land and promote fisheries. So, the politicians should be united to pull the country out of this crisis.

In addition to this, proper use of national resources and modern technology can extirpate this crisis from the land of resilient. Pakistan is rich in natural resources. There are reserves of coal in millions of tons. Besides coal, the country has natural gas in Balochistan as well. These resources are needed to be exploited in proper manner to address this issue.

Furthermore, reforms in regulation and distribution of electricity are need of the hour. Line losses and power theft can also be hindered through modern and advanced technological tools. Hundreds of mega-watts of electricity are wasted in terms of theft. Impediments in the way of theft can do much in lessening the impact of energy crisis. Removal of corrupt officers and stoppage of theft can contribute to a large extent to get rid of this menace.

Furthermore, farsightedness of government is required to tackle the problem permanently. Government should work according to increasing needs of energy. It must consider the circumstances that can affect the country in coming days. If dams were built by previous governments, there would have been no energy crisis today. So, the present government should do something to overcome the existing crisis as well as to secure the country's future. This kind of vision can eradicate energy crisis in Pakistan.

Similarly, investigative and vibrant role of media is the key to uproot energy crisis to a large extent. Media should play its due role in this regard. Investigation to curtail power theft can ameliorate the condition. Awareness can also be spread among masses through electronic as well as print media to use electricity with care. Media should make people aware pertaining to proper use of energy. It should inform people that extra lights and fans must be turned off. Wastage of energy must be discouraged nationally.

Last but not least, population control can also bring desired results. Owing to growing population, usage of energy is increasing. This was not the case two decades back. Government should make people understand well that overpopulation will further aggravate the situation. This formula can do much in lessening the graveness of energy crisis.

To conclude, it can be said that energy crisis has reached an alarming stage. It is causing problems for Pakistanis in several walks of life. Amid all others, economy has received a huge setback. Hundreds of industries are closed due to long power cuts. It results in unemployment and poverty. Solution to this problem can improve the situation. Its solution can ensure progress and prosperity of the country. On the contrary, if this problem is not eradicated in time, it will add to hardships of people. Cost of living will go up if energy crisis is not overcome. The solution needs full determination and strong political will. It can be extirpated with the help of these two.

ENERGY (MCQS)

Note: Answers are Bold and Underlined:

1. **Fossils fuels are rich in carbon and:**
   (a) Nitrogen (b) **Hydrogen** (c) Nitrogen (d) Oxygen
2. **Fossils fuels are important sources of energy in:**
   (a) Transport (b) Homes (c) Industries (d) **All of them**
3. **When animal and plant materials rot in absence of air there is production of gas called:**
   (a) Oxygen (b) Carbon dioxide (c) **Bio gas** (d) Methane
4. **Earth releases its heat by eruptions of:**
   (a) Volcano (b) Hot springs (c) Geysers (d) **All of these**
5. **Plant materials, vegetation and waste from living things are regarded as:**
   (a) Fossil fuel (b) **Biomass** (c) Coal (d) Crude
6. **Bio gas is renewable source of:**
   (a) **Energy** (b) Heat (c) Light (d) Fossil
7. **Burning of fossil fuels are leading towards:**
   (a) Pollution (b) Global warming (c) **Both (a) and (b)** (d) None of these
8. **Energy resources which will not run out in long-term are called:**
   (a) **Renewable** (b) Non-renewable (c) Generating (d) Producing
9. **To harness solar energy products which are helpful are:**
   (a) Solar furnace (b) Solar heater (c) Solar cells (d) **All of these**
10. **A dangerous activity which resulted in many deaths due to gas explosion, or flooding is:**
    (a) **Coal mining** (b) Climbing mountain
    (c) Extracting oil (d) Hydropower generation

11. **Need and demand of fossil fuels can be reduced by:**
(a) Conserving energy (b) Storing energy
(c) Utilizing energy (d) Transforming energy

12. **Toxic air pollutants like sulphur dioxide and nitrogen oxides are produced by burning:**
(a) Coal (b) Oil (c) Both (a) and (b) (d) Gases

13. **Fossil fuels are regarded as energy resources which are:**
(a) Renewable (b) Non-renewable (c) Generating (d) Producing

14. **Which of the following is a non-renewable energy resource?**
(a) Solar (b) Biogas (c) Hydroelectric (d) Coal

15. **What is the leading source of energy used in the Pakistan today?**
(a) Coal (b) Oil resources (c) Natural gas (d) Nuclear power

16. **Oil, coal and natural gas supply approximately ______ percent of the energy used i Pakistan:**
(a) 10 (b) 45 (c) 65 (d) 90

17. **Harmful radiation emitted by the sun is ____________.**
(a) Visible (b) Infra-red (c) Ultra-violet (d) Radio waves

18. **Which of the following causes the least pollution when burnt?**
(a) Petrol (b) Diesel (c) Coal (d) Natural gas

19. **The main constituent of LPG is __________.**
(a) Methane (b) Butane (c) Hydrogen (d) Propane

20. **The main constituent of CNG is __________.**
(a) Methane (b) Pentane (c) Ethane (d) Propane

21. **Which of these is not a renewable source of energy?**
(a) The Solar (b) Natural gas (c) Wind (d) Tidal energy

22. **The radiations emitted by a hot furnace are __________.**
(a) Ultra-violet (b) Infra-red (c) X-rays (d) Micro waves

23. **A solar cell is made up of:**
(a) Silicon (b) Titanium (c) Magnesium (d) Teflon

24. **Which of the following is not combustible?**
(a) Oxygen (b) Hydrogen (c) Butane (d) Methane

25. **In a solar panel, the metal used is ___________.**
(a) Gold (b) Copper (c) Silver (d) Nickel

26. **A solar cell converts ___________.**
(a) Heat energy into electrical energy (b) Solar energy into electrical energy
(c) Heat energy into light energy (d) Solar energy into light energy

27. **The source of energy of the sun is ___________.**
(a) Nuclear fission (b) Chemical reaction
(c) Nuclear fusion (d) Photoelectric effect

28. **Which of the following statements is NOT true about kinetic energy?**

(a) Anything which is moving has kinetic energy.

(b) The kinetic energy of something depends on its height.

(c) The kinetic energy of something depends on its mass.

(d) The kinetic energy of something depends on its speed.

29. **Which of the following statements is NOT true about gravitational potential energy?**

(a) Gravitational potential energy is due to height.

(b) The gravitational potential energy of something depends on its mass.

(c) The gravitational potential energy of something depends on its height.

(d) The gravitational potential energy of something depends on its speed.

30. **There are three (or four) different methods of heat transfer. Which of the following is NOT one of them?**

(a) Nuclear Radiation (b) Conduction

(c) Convection (d) Heat Radiation

31. **What does the law of conservation of energy state?**

(a) Energy cannot be made or destroyed, but it can be changed from one form to another.

(b) Energy can be created or destroyed, but it cannot be changed from one form to another.

(c) Energy cannot be made or destroyed, nor can it be changed from one form to another.

(d) Energy can be created or destroyed, and it can be changed from one form to another.

32. **Non-renewable fuels are very polluting and are running out quickly. Which of the following is NOT an advantage of using coal, oil, gas or nuclear energy?**

(a) High power output. (b) Reliable output.

(c) There are no fuel costs. (d) They do not use up much land.

33. **Which of the following is NOT an advantage of using renewable energy?**

(a) Create no pollution.

(b) No fuel costs, except for wood burning.

(c) Have minimal running costs.

(d) They all give a very reliable power output.

34. **Sun, wind, running water, tides, biomass, and geothermal resources are accounted as:**

(a) Renewable (b) Non-renewable (c) Generating (d) Producing

35. **SI unit for energy is:**

(a) Watt (b) Joule (c) Newton (d) Kilogram

36. **Examples of renewable resources include all of the following except:**

(a) Solar power (b) Coal (c) Wind power (d) Water power

37. **What is one of the primary advantages of oil over coal as an energy source?**

(a) It is less expensive to produce. (b) It is easier to find.

(c) It is lighter. (d) It is liquid.

38. **Coal is formed from:**

(a) Land plants (b) Marine plants & algae

(c) Animals (d) Dinosaurs

39. **Which type of coal has the highest energy content?**

(a) Bituminous (b) Sub-bituminous (c) Anthracite (d) All of these

40. **Adverse environmental impacts of coal mining include all of the following except:**

(a) Decreasing input of carbon dioxide to the atmosphere.

(b) Acid mine drainage.

(c) Permanently altered streams and ecosystems.

(d) Subsidence and collapse of the ground.

41. **Petroleum is formed from:**

(a) Land plants (b) Marine algae (c) Marine organisms (d) Dinosaurs

42. **How is biofuel made?**

(a) By fermenting the sugar components of starch crops.

(b) By reacting vegetable oil or animal fat with an alcohol.

(c) By treating plant oil or animal fat with hydrogen.

(d) All of these.

43. **How does ethanol's energy output compare to that of gasoline?**

(a) It's one-third as much. (b) It's two-thirds as much.

(c) It's three-quarters as much. (d) It's about equal.

44. **What is the primary source of biodiesel?**

(a) Soybeans (b) Plant oil (c) Animal fat (d) All of these

45. **Adverse environmental impacts of oil and gas production include all of the following except:**

(a) Air pollution with carbon monoxide. (b) Damage to ecosystems caused by spills.

(c) Damage to the ozone layer caused by oil spills.

(d) Air pollution with nitrogen oxide.

46. **Ethanol is biofuel and is known as:**

(a) Carbon neutral (b) Hydrogen neutral (c) Oxygen neutral (d) All of these

47. **Leading petroleum consumer in the world:**

(a) USA (b) China (c) Japan (d) India

48. **Leading petroleum producer in world:**

(a) Saudi Arabia (b) Russia (c) USA (d) Iran

49. **World's largest proven oil reserve are in:**

(a) Saudi Arabia (b) Venezuela (c) Canada (d) Iran

50. **Top coal producer in the world is:**

(a) China (b) USA (c) India (d) Europe

CHAPTER 15

MODERN MATERIALS AND CHEMICALS

CERAMICS

"A ceramic is an inorganic non-metallic solid made up of clay that have been shaped and then hardened by heating to high temperatures." Ceramics are all around us. This category of materials includes things like tile, bricks, plates, glass, and toilets. Ceramics can be found in products like watches automobiles (sparkplugs and ceramic engine parts found in race cars). They can also be found on space shuttles, appliances (enamel coatings), and airplanes (nose cones). Nowadays, the term 'ceramic' has a more expansive meaning and includes materials like glass, advanced ceramics and some cement systems as well.

General Properties

The properties of ceramic materials, like all materials, are dictated by the types of raw materials present. Due to ceramic materials' wide range of properties, they have diverse applications. In general, most ceramics have following properties:

1. Ceramics are hard, extremely strong, showing considerable stiffness under compression and bending.
2. Ceramics are wear-resistant and durable, therefore, are used in industry.
3. Ceramics are refractory material with a high melting point that is used to line the inside walls of a furnace.
4. Ceramics are corrosion-resistant.
5. Ceramics are inert to chemical action and generally do not react with most liquids, gases, alkalis, and acids.
6. Ceramics are thermal insulators and electrical insulators but certain ceramics conduct electricity. Chromium dioxide, for example, conducts electricity as most metals do.
7. Ceramics are non-magnetic but ceramics containing iron oxide (Fe_2O_3) can have magnetic properties similar to those of iron.
8. Ceramics are primarily oxides, carbides, nitrides, borides and silicates.
9. Ceramics are oxidation-resistant
10. Ceramics are brittle, having little elasticity.

How Ceramics are produced

Firing is the process by which ceramics have traditionally been made; indeed, the word "ceramic" can be traced back to a Sanskrit word meaning "to burn." Simple ceramics such as bricks and certain types of glass are still made by processes that would be recognized by people who lived thousands of years ago. Just as in ancient times, today's pottery is made by digging clay from the ground, mixing it with water to make it flexible, shaping it on a wheel or in a mold, and then firing it in a kiln. Some of today's processes are more sophisticated than the techniques of past times. Machines have long been used in processes such as extrusion (forcing a material into shape by squeezing it like toothpaste through a shaped tool), jiggering (laying the material automatically into a rotating mold), or hot pressing (forcing a powdered form of the ceramic into a mold then simultaneously heating it and pressing it to fuse the material into shape).

The latest industrial ceramics sometimes demand more advanced production processes. Extremely tough ceramics made of silicon nitride are made by a method called reaction bonding. This involves forming silicon powder into the desired shape then heating it with nitrogen gas. Because the silicon powder already occupies the same volume as the finished product, grains of silicon nitride can form only by fusing together tightly.

Applications

Ceramic materials display a wide range of properties which facilitate their use in many different product areas. Ceramics have application in the following areas:

- **Aerospace:** Ceramics are used in the formation of parts of space shuttle, rockets and space stations.
- **Consumer Usage:** Ceramics have great usage in our homes like glassware, pottery, dinnerware and home electronics.
- **Automotive Industry:** Ceramics are widely used in automotive industry. For example, catalytic converters, filters, rotors, valves, spark plugs, thermostats and piston rings are ceramics.
- **Medical (Bio-ceramics):** Ceramics are used in medical field especially in dental and bone fillings and in bone implants.
- **Military Equipment:** Structural components for ground, air and naval vehicles of military are made from ceramics.
- **Computers and Electronics:** Computer parts like insulators, resistors, superconductors, capacitors, etc. are made up of ceramics.
- **Abrasives:** Abrasives are used for grinding, cutting, polishing of materials. Abrasives are natural (garnet, diamond) and synthetic (silicon carbide, diamond, fused alumina). These are all ceramics.
- **Building and Construction:** Manufacturers use ceramics to make bricks, tiles, piping and other construction materials.
- **Coatings:** Ceramic materials are more corrosion-resistance than most metals, manufacturers often coat metal with ceramic enamel.

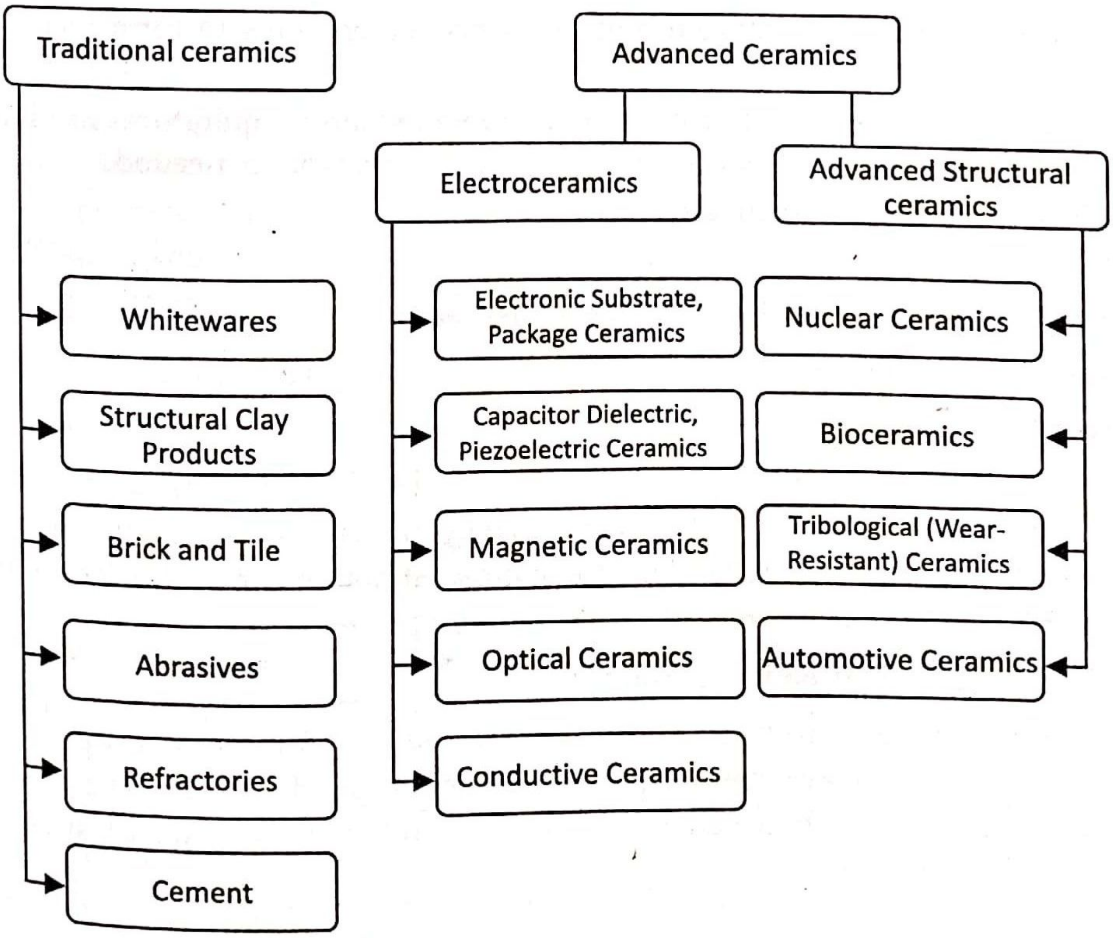
- **Nuclear Ceramics:** Nuclear ceramics, ceramic materials employed in the generation of nuclear power and in the disposal of radioactive nuclear wastes.
- **Optical Ceramics:** Optical Ceramics are polycrystalline materials produced through controlled crystallization of base glass. Glass-ceramic materials share many properties with both glasses and ceramics. These have various applications including optical fibres, optical switches, Laser amplifiers and lenses.
- **Tribological Ceramics:** Tribological ceramics, also called wear-resistant ceramics, ceramic materials that are resistant to friction and wear. They are being used today in diverse applications such as tips for ball-point pens, precision instrument bearings, and cutting tool inserts.
- **Refractories:** Refractory is one that retains its strength at high temperature. Examples include kiln linings, gas fire radiant, steel and glass making crucibles

Classification of Ceramics

There are various classification systems of ceramic materials, which may be attributed to one of two principal categories: application base system or composition base system.

Application Based Classification of Ceramic Materials

On the basis of application, ceramics can be classified into traditional and advanced ceramics. Detailed classification is given in the following diagram:



Classifications of Ceramics on Basis of Composition

Ceramics can be classified into three distinct material categories:

- **Oxides:** alumina, zirconia, iron oxide, etc.
- **Non-oxides:** carbides, borides, nitrides and silicides.
- **Composites:** combinations of oxides and non-oxides.

PLASTICS

Plastics are materials made up of large organic molecules that can be formed into a variety of products. The molecules that compose plastics are long carbon chains that give plastics many of their useful properties. The word plastic is derived from the words plasticus (Latin for "capable of being moulded") and plastikos (Greek "to mould," or "fit for moulding").

General Properties

1. They are lighter than many materials of comparable strength unlike metals and wood.
2. Plastics do not rust or rot; they are corrosion-resistant and oxidation-resistant.
3. Most plastics can be produced in any colour. They can also be manufactured transparent, translucent (transmitting small amounts of light), or opaque.
4. Plastics have a lower density than that of metals.
5. Plastics can also be reinforced with glass and other fibres to form incredibly strong materials.
6. Certain plastics are specifically designed to withstand temperatures as high as 288°C; in general, plastics are not used when high heat resistance is needed.
7. Plastics are electrical insulators.
8. Plastics are non-magnetic in nature.
9. Plastics are chemically stable and somewhat inert.
10. Plastics are not brittle.

Chemistry of Plastics

Plastics are organic molecules each composed of carbon atoms linked into chains called **polymers.** For example, one type of plastic known as polyethylene is composed of extremely long molecules that each contains over 200,000 carbon atoms. Although some plastics are made from plant oils, the majority are made from fossil fuels.

Thermoplastics and Thermosetting Plastics

Plastics can be divided into two groups: thermoplastics and thermosetting plastics. These terms refer to the different ways these types of plastics respond to heat. The reason for the difference in response to heat between thermoplastics and thermosetting plastics lies in the chemical structures of the plastics.

Thermoplastics

Thermoplastics can be heated and cooled, and consequently softened and hardened, repeatedly, like candle wax. For this reason, thermoplastics can be remoulded and reused almost indefinitely. Thermoplastic molecules are linear or slightly branched and do not chemically bond with each other when heated. Instead, thermoplastic chains are held together by weak vander Waal forces (weak bonds) that cause the long molecular chains to clump together like piles of entangled spaghetti.

Because thermoplastic materials consist of individual molecules, properties of thermoplastics are largely influenced by molecular weight. For instance, increasing the molecular weight of a thermoplastic material increases its tensile strength, impact strength and fatigue strength (ability of a material to withstand constant stress). Polyvinyl, Polystyrene, Polyethylene and PTFE are examples of thermoplastics.

Thermosetting Plastics

Thermosetting plastics harden permanently after being heated once. These consist of chain molecules that chemically bond or cross-link with each other when heated. When thermosetting plastics cross-link, the molecules create a permanent, three-dimensional network that can be considered one giant molecule. Once cured thermosetting plastics cannot be re-melted in the same way as the cured concrete cannot be reset. Consequently, thermosetting plastics are often used to make heat-resistant products because these plastics can be heated to temperatures of 260°C (500° F) without melting.

Thermosetting plastics consist of a single molecular network; molecular weight does not significantly influence the properties of these plastics. Instead, many properties of thermosetting plastics are determined by adding different types and amounts of fillers and reinforcements, such as glass fibres. Bakelite, Duraplast, Melamine, Epoxy Resin and Acrylic are the examples of thermosetting plastics.

Importance and Usage of Plastics

Plastics are indispensable to our modern way of life. Many people sleep on pillows and mattresses filled with a type of plastic either cellular polyurethane or polyester. At night, people sleep under blankets and bedspreads made of acrylic plastics and in the morning they step out of bed onto polyester and nylon carpets.

The cars we drive, the computers we use, the utensils we cook with, the recreational equipment we play with, and the houses and buildings we live and work in all, include important plastic components. The average car contains almost 136 kg (almost 300 lbs) of plastics nearly 12 per cent of the vehicle's overall weight.

Telephones, textiles, compact discs, paints, plumbing fixtures, boats and furniture are other domestic products made of plastics. Plastics are used extensively by many key industries, including the automobile, aerospace, construction, packaging and electrical industries.

The aerospace industry uses plastics to make strategic military parts for missiles, rockets, and aircraft. Plastics are also used in specialized fields, such as the health industry, to make medical instruments, dental fillings, optical lenses and biocompatible joints.

Advantages of Plastic

1. Plastics are light in weight and can be easily moulded.
2. Plastics possess very good strength and toughness.
3. Plastics possess good shock absorption capacity.
4. Plastics are corrosion-resistant and chemically inert.
5. Plastics possess good thermal and electrical insulating property.
6. Plastics is very good water resistant and possess good adhesiveness.
7. Plastics is a recyclable material and it does not decompose.

Hazards of Plastics

1. Chemicals added to plastics are absorbed by human bodies. Some of these compounds have been found to alter hormones or have other potential human health effects.
2. Plastic debris, laced with chemicals and often ingested by marine animals, can injure or poison wildlife.
3. Floating plastic waste, which can survive for thousands of years in water, serves as mini transportation devices for invasive species, disrupting habitats.
4. Plastic buried deep in landfills can leach harmful chemicals that spread into groundwater.
5. Around 4% of world oil production is used as a feedstock to make plastics, and a similar amount is consumed as energy in the process.
6. People are exposed to chemicals from plastic multiple times a day through the air, dust, water, food and use of consumer products.
7. In addition, burning plastics can sometimes result in toxic fumes.

Plastic Waste Management: Reduce, Reuse and Recycle

Alternative methods for reducing and disposing of plastic wastes are being explored. Some of these options include reducing consumption of plastics, using biodegradable plastics and incinerating or recycling plastic waste. It is also called 3R strategy: reduce, reuse and recycle.

Source reduction is the practice of using less material to manufacture a product. For example, the wall thickness of many plastic and metal containers has been reduced in recent years, and some European countries have proposed to eliminate packaging that cannot be easily recycled. Since refillable plastic containers can be reused for many times, container reuse can lead to a substantial reduction in the demand for disposable plastic and reduced use of materials and energy, with the consequent reduced environmental impacts.

All plastics can be recycled. Thermoplastics can be re-melted and made into new products. Thermosetting plastics can be ground, mixed, and then used as filler in mouldable thermoplastic materials. Highly filled and reinforced thermosetting plastics can be pulverized and used in new composite formulations.

In addition to reducing the amount of plastics waste requiring disposal, recycling and reuse of plastic can have several other advantages, such as: Conservation of non-renewable fossil fuels – Plastic production uses 8% of the world's oil production, 4% as feedstock and 4% during manufacture; reduced consumption of energy; reduced amounts of solid waste going to landfill and reduced emissions of carbon-dioxide (CO_2), nitrogen-oxides (NOx) and sulfur-dioxide (SO_2).

Biodegradable Plastics

Due to their molecular stability, plastics do not easily break down into simpler components. Plastics are therefore not considered biodegradable. However, researchers are working to develop biodegradable plastics that will disintegrate due to bacterial action or exposure to sunlight. For example, scientists are incorporating starch molecules into some plastic resins during the manufacturing process. When these plastics are discarded, bacteria eat the starch molecules. This causes the polymer molecules to break apart, allowing the plastic to decompose.

Major types of Plastics

Plastic molecules are made of long chains of repeating units called monomers. The atoms that make up a plastic's monomers and the arrangement of the monomers within the molecule both determine many of the plastic's properties. This table lists the monomers for several major plastics, along with the properties and uses of each type of plastic.

Chemical Name	Properties	Application
Polyethylene (PE)	Thermoplastic; translucent; permeable by hydrocarbons, alcohol, and gas; resistant to X-rays and chemical agents.	Film, bags, pipe and tubing, insulating sleeves, bottle stoppers, lids, plastic wrap, toys.
Polypropylene (PP)	Thermoplastic; low density; durable; resistant to X-rays; permeable by water; impact-resistant and temperature-resistant to 135 °C.	Household items, plastic wrap, automobile parts, batteries, bumpers, garden furniture, syringes, bottles, appliances.
Polystyrene (PS)	Thermoplastic; transparent; non-toxic; optical and electrical properties; easy to colour; resistant to X-rays, oils, and grease.	Plastic wraps kitchen utensils, furniture covers, thermal insulation, toys, office supplies, disposable razors.
Polyvinyl Chloride (PVC)	Thermoplastic; soft or rigid; opaque or transparent; fire-resistant; resistant to X-rays,	Household items, electric wire insulation, water pipes, floor coverings, window and door coverings, baggage,

	acids, bases, oils, grease, and alcohol.	vinyl, sport and camping gear, items for chemical and automobile industries.
Polytetrafluoroethylene (PTFE) or Teflon	Chemically inert, anti-adhesive, impermeable to water and grease, heat-and corrosion-resistant.	Orthopaedic and prosthetic appliances, hearing aids, joints, upholstery, corrosion-resistant mechanical parts, electrical insulation, frying pan coatings.
Polymethyl Methacrylate (PMMA) or Plexiglas	Thermoplastic, optical properties, ages well, weather-resistant.	Glass substitute, neon signs, windows, portholes, optical fibres, dentistry, appliances, contact lenses.
Polyamides (PA) (example: Nylon)	Thermoplastic, mechanical properties, durable to temperatures up to 100 °C, resistant to X-rays and fuel, impermeable to odours and gases.	Food wrap, counters, gas, electricity, fuel pipes, shoes, ski bindings, bicycle seats.
Silicone	Fluid, lubricant, anti-adhesive, slightly toxic.	Fluid for electrical transformers, putty, moulding, anti-adhesive coverings, varnish, wax, burn treatments, cosmetic surgery.
Urea-Formaldehyde (UF)		Organic glass, dishes.
Polyesters	Thermosetting, transparent, mechanical properties at high temperatures, electrical properties, resistant to impact, easy to work with.	Textiles, plastic wraps bottles, switches, electric sockets and fuses, appliances.

FERTILIZER

"Fertilizer is any organic or inorganic material of natural or synthetic origin that is added to a soil to supply one or more nutrients essential to the growth of plants." There are 16 essential elements needed by plants to grow. The most important of these are nitrogen, phosphorus and potassium (NPK). Without nitrogen, phosphorus and potassium, the plant simply cannot grow because it cannot make the food it needs. If any of these are missing or hard to obtain from the soil, this will arrest the growth rate for the plant. To make plants grow faster, fertilizers supply the elements that the plants need in readily available forms. Nutrients can be classified into macro and micro-nutrients.

Macro-nutrients

Macronutrients are the elements require in large quantities. Macro-nutrients can be broken down into two more groups: primary and secondary nutrients. The **primary nutrients** are nitrogen (N), phosphorus (P) and potassium (K). These major nutrients usually are lacking from the soil because plants use large amounts for their growth and survival. The **secondary nutrients** are calcium (Ca), magnesium (Mg) and sulphur (S). There are usually enough of these nutrients in the soil so fertilization is not always needed. Also, large amounts of calcium and magnesium are added when lime is applied to acidic soils.

Micro-nutrients

Micro-nutrients are the elements essential for plant growth and which are needed in only very small (micro) quantities. These elements are sometimes called minor elements or trace elements. The micro-nutrients are boron (B), copper (Cu), iron (Fe), chloride (Cl), manganese (Mn), molybdenum (Mo) and zinc (Zn).

Classification

Fertilizers are classified in many ways. They are classified according to whether they provide a single nutrient (say, N, P, or K), in which case they are classified as "**straight fertilizers.**" "**Multinutrient fertilizers**" (or "complex fertilizers") provide two or more nutrients, for example N and P. Fertilizers can also be classified according to their mode of operation in the soil. They are as follows:

1. **Direct Fertilizers:** The fertilizers which are directly assimilated by the plants are called direct fertilizers. For example, super phosphate, nitrate and ammonium compounds. These contain nutrient elements in the form of mineral salts which can be absorbed directly.
2. **Indirect Fertilizers:** These are the substances which are introduced into the soil mainly to improve its mechanical, chemical or biological properties. Ground dolomite $CaMg(CO_3)_2$ and limestone $CaCO_3$ are used to reduce soil acidity, and gypsum $CaSO_4.2H_2O$ is used to improve the properties of soils with a high salt content are the examples of indirect fertilizers.
3. **Complete Fertilizers:** These contain all the principal ingredients (NPK) for the growth of plants in the combined form, so that an additional fertilizer is not necessary. Zor-Aawar and Zarkhaiz by Engro Fertilizer are the examples of complete fertilizers.
4. **Incomplete Fertilizers:** These fertilizers contain only one or two needed elements (NPK) such as ammonium nitrate or potassium chloride and provide nitrogen and potassium, respectively. They supply only a part of the requirements.
5. **Mixed Fertilizers:** Fertilizers obtained by mechanical mixing of various fertilizers are known as mixed fertilizers. For example, urea mixed with single super phosphate and potash.
6. **Microfertilizers:** These contain the elements boron, manganese, zinc and copper needed in very small amounts to stimulate the plant growth.

Types of Fertilizers (on the basis of nutrient supplied)

- **Nitrogenous fertilizers**
  - Urea
  - Ammonium sulphate
  - Calcium ammonium nitrate
- **Phosphatic fertilizers**
  - Single superphosphate
  - Triple superphosphate
  - Diammonium phosphate

  - Monoammonium phosphate
- **Potassic fertilizers**
  - Sulphate of potash
  - Muriate of potash

Environmental Hazards of Fertilizers

Nutrient Pollution: Farming operations can contribute to **nutrient pollution** when not properly managed. Fertilizers and animal manure, which are both rich in nitrogen and phosphorus, are the primary sources of nutrient pollution from agricultural sources. Excess nutrients can impact water quality when it rains or when water and soil containing nitrogen and phosphorus wash into nearby waters or leach into ground waters.

Eutrophication: Fertilisers are often used in farming, sometimes these fertilisers run-off into nearby water causing an increase in nutrient levels. This causes phytoplankton to grow and reproduce more rapidly, resulting in algal blooms. This bloom of algae disrupts normal ecosystem functioning and causes many problems. The algae may use up all the oxygen in the water, leaving none for other marine life. This results in the death of many aquatic organisms such as fish, which need the oxygen in the water to live. The bloom of algae may also block sunlight from photosynthetic marine plants under the water surface. Some algae even produce toxins that are harmful to higher forms of life. This can cause problems along the food chain and affect any animal that feeds on them.

Groundwater Pollution: When high rates of nitrogen are used especially on sandy or permeable soils, inevitably some nitrate is leached and may enter groundwater if there is a water table. If this groundwater is used for domestic supplies, the leaching presents a serious health hazard.

Soil Acidity: There are three major acidifying processes: first is the addition of nitrogen to the soil by fertilizer or fixation of atmospheric nitrogen, followed by loss of nitrate from the soil due to leaching or run-off. Second is production of organic acids from decomposing organic matter and lastly, removal of alkaline products such as hay from the soil. Pakistani soils are becoming acidic due to heavy use of nitrogenous fertilizer.

Health Hazards: Health hazards of chemical fertilizers are birth defects, reproduction problems, liver damage, kidney damage, Blue Baby syndrome and reduced immune response. Some fertilizer has been found to contain dioxin, one of the most dangerous environmental chemicals ever identified, and heavy metals such as lead, cadmium and mercury. Children are most vulnerable to the toxic effects of most metals, especially lead.

Solution to fertilizer Pollution

There are many ways that agricultural operations can reduce nutrient pollution, including:

- **Nutrient management:** Applying fertilizers in the proper amount, at the right time of year and with the right method can significantly reduce the potential for pollution.
- **Cover crops:** Planting certain grasses, grains or clovers can help keep nutrients out of the water by recycling excess nitrogen and reducing soil erosion.

- **Buffers:** Planting trees, shrubs and grass around fields, especially those that border water bodies, can help by absorbing or filtering out nutrients before they reach a water body.
- **Conservation tillage:** Reducing how often fields are tilled reduces erosion and soil compaction, builds soil organic matter, and reduces runoff.
- **Managing livestock waste:** Keeping animals and their waste out of streams, rivers and lakes keeps nitrogen and phosphorus out of the water and restores stream banks.
- **Drainage water management:** Reducing nutrient loadings that drain from agricultural fields helps prevent degradation of the water in local streams and lakes.

PESTICIDES

A **pesticide** is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. **Pests** can be defined as any organism that causes economic losses to mankind. These include insects, weeds, Rodents and worms etc. Pesticides can be classified on the basis of pest-controlled (agronomic classification), chemical nature and mode of entry.

Insecticide Classification Based on Pest Target

This is also called *Agronomic classification.*

1. **Fungicides:** These kill fungi including blights, mildews, moulds and rusts.
2. **Fumigants:** These produce gas or vapours intended to destroy pests in buildings or soil.
3. **Herbicides:** These kill weeds and other plants that grow where they are not wanted.
4. **Insecticides:** These kill insects and other arthropods.
5. **Miticides:** These kill mites that feed on plants and animals.
6. **Molluscicides:** These kill snails and slugs.
7. **Nematicides:** These kill nematodes (microscopic, worm-like organisms that feed on plant roots).
8. **Repellents:** These repel pests, including insects such as mosquitoes.
9. **Rodenticides:** These control mice and other rodents.
10. **Arachnicide:** These control spiders

Insecticide Classification Based on Chemical Nature

One traditional classification of pesticides places them in one of two groups: **organic** and **inorganic. Organic pesticides** are based on chemicals having carbon as the basis of their molecular structure. The chemicals in organic pesticides are more complex than those of inorganic pesticides, and usually do not dissolve easily in water. **Inorganic pesticides** are simpler compounds. They have a crystalline, salt-like appearance, are environmentally stable, and usually dissolve readily in water. The earliest chemical pesticides were inorganic, and included substance such as sulphur and lime.

Organic pesticides can be subdivided into two additional groups: the **natural organics,** and the **synthetic organics.** The natural organic pesticides are derived from naturally occurring sources such as plants. Rotenone and pyrethrum are examples of natural organic pesticides. Synthetic organic pesticides are produced artificially by chemical synthesis. This group comprises most "modern" pesticides, and includes DDT, permethrin, malathion, 2, 4-D, glyphosphate, and many, others.

Insecticide Classification Based on Mode of Entry

1. **Stomach Poison** — insecticide enters the body through the mouth of the pest and acts in the stomach.
2. **Contact Poison** —insecticides enter the body through the integument into the blood or into the respiratory system through the spiracles.
3. **Fumigant Poison** —these are volatile poisons that enter the body though the respiratory system.

Hazards of Pesticides

1. **Pesticides kill beneficial insects:** Chemical insecticides are rarely selective and kill a large number of insects, including the good ones.
2. **Pesticides Invoke Resistance:** Insect pests have an uncanny ability to develop resistance to conventional insecticides. Currently, there are more than 500 insect pest and mite species that have shown resistance. In fact, some of the most destructive pests cannot be controlled with today's chemicals.
3. **Drift of Sprays and Vapour:** Pesticides can affect other areas during application and can cause severe problems in different crops, livestock, waterways and the general environment. Wildlife and fish are the most affected.
4. **Residues in Food:** There is possibility of pesticides in human food, either by direct application onto the food, or by bio-magnification along the food line.
5. **Groundwater Contamination:** Chemicals can reach underground aquifers if there is persistent product use in agricultural areas.
6. **Poisoning Hazards:** Pesticide operators can risk poisoning through excessive exposure if safe handling procedure are not followed and protective clothing is not worn. Poisoning risks depend on dose, toxicity, duration of exposure and sensitivity. Pesticides are also used as a **suicidal agent**. So extreme care is needed for their handling and storage.
7. **Pesticides and Human Health:** Pesticides have been linked to a wide range of human health hazards, ranging from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive problems and endocrine disruption. Acute dangers include nerve, skin and eye irritation and damage, headaches, dizziness, nausea, fatigue and systemic poisoning.

Solution to Pesticides

We need to make our food, air, water, and soil free from toxic chemicals. The real solution to our pest and weed problems lies in non-toxic and cultural methods of agriculture, not in pulling the pesticide trigger. Organically grown foods and sustainable methods of pest control are key to our families' health and the health of the environment.

Better testing. Provincial and federal agencies should require stricter independent testing, including testing of synergistic effects of pesticides. Pesticides known or suspected of causing human health problems should be phased out.

Protect our children. Because our children are the most vulnerable population to pesticides, pesticide use should be prohibited in places where our children live and play, including schools, parks, and playgrounds. Require strict non-toxic pest management programs for such places.

Pesticide Use Reduction. Provide technical assistance to farmers, local governments, businesses, and homeowners on non-toxic alternatives to pesticide use. This includes alternatives to nuisance spraying for mosquitoes and controlling other pest problems.

Protect workers. Provide protection to workers and farmers to prevent acute and chronic pesticide poisoning.

SEMICONDUCTOR

Semiconductors are used extensively in electronic circuits. As its name implies, a semiconductor is a material that conducts current, but only partly. The conductivity of a semiconductor is somewhere between that of an insulator, which has almost no conductivity, and a conductor, which has almost full conductivity. Most semiconductors are crystals made of certain materials. The common semiconductors include chemical elements and compounds such as silicon, germanium, selenium, gallium arsenide, zinc selenide and lead telluride.

To understand how semiconductors work, you must first understand a little about how electrons are organized in an atom. The electrons in an atom are organized in layers. These layers are called shells. The outermost shell is called the valence shell.

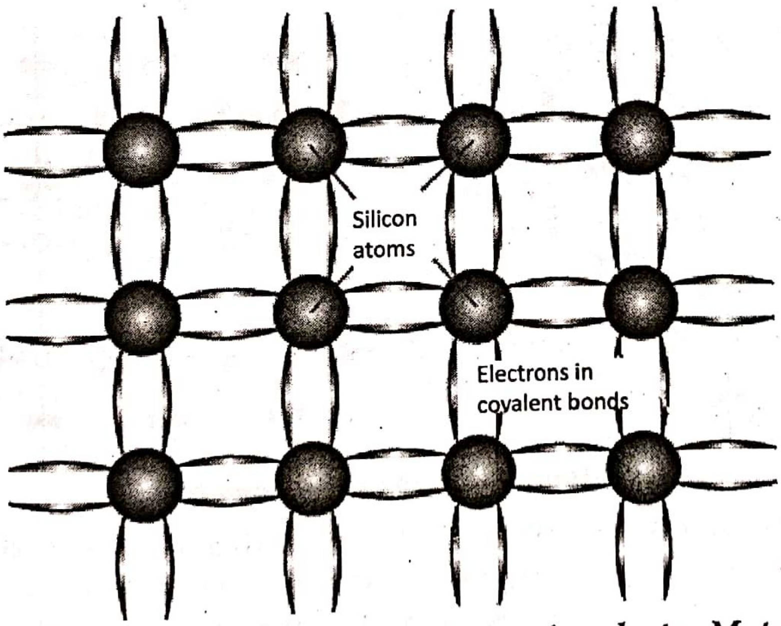


Figure: Arrangement of electrons in a semiconductor Materials

The electrons in this shell are the ones that form bonds with neighboring atoms. Most conductors have just one electron in the valence shell. Semiconductors, on the other hand, typically have four electrons in their valence shell. If all the neighboring atoms are of the same type, it's possible for all the valence electrons to bind with valence electrons from other atoms. When that happens, the atoms arrange themselves into structures called crystals. Semiconductors are made out of such crystals, usually silicon crystals.

Here, each circle represents a silicon atom, and the lines between the atoms represent the shared electrons. Each of the four valence electrons in each silicon atom is shared with one neighboring silicon atom. Thus, each silicon atom is bonded with four other silicon atoms. Pure silicon crystals are not all that useful electronically as they conduct electric current only partly. But if you introduce small amounts of pentavalent or trivalent elements into a crystal, the crystal starts to conduct in an interesting way.

The process of deliberately introducing other elements into a crystal is called bold. The element introduced by doping is called a dopant. By carefully controlling the doping process and the dopants that are used, silicon crystals can transform into one of two distinct types of conductors: N type and P type semiconductor.

N-type semiconductor: Created when the dopant is an element that has five electrons in its valence layer. Phosphorus is commonly used for this purpose. The phosphorus atoms join right in the crystal structure of the silicon, each one bonding with four adjacent silicon atoms just like a silicon atom would (See diagram below). Because the phosphorus atom has five electrons in its valence shell, but only four of them are bonded to adjacent atoms, the fifth valence electron is left hanging out with nothing to bond to. The extra valence electrons in the phosphorous atoms start to behave like the single valence electrons in a regular conductor such as copper. They are free to move about. Because this type of semiconductor has extra electrons, it's called an N-type semiconductor.

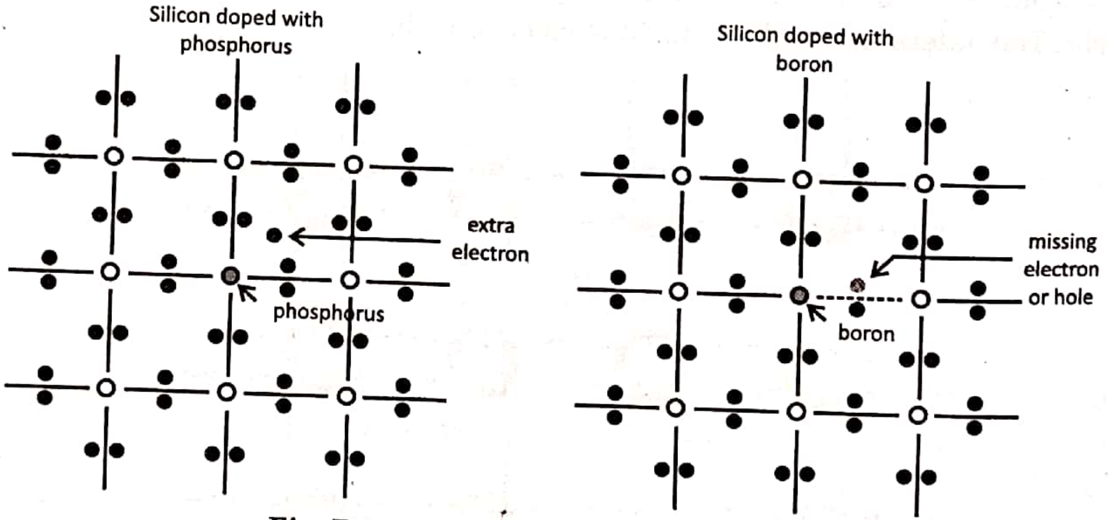


Fig: P-type and N-type semiconductor

P-type semiconductor: Happens when the dopant (such as boron) has only three electrons in the valence shell. When a small amount is incorporated into the crystal, the atom is able to bond with four silicon atoms, but since it has only three electrons to offer, a hole is created. The hole behaves like a positive charge, so semiconductors doped in this way are called P-type semiconductors. Like a positive charge, holes attract electrons. But when an electron moves into a hole, the electron leaves a new hole at its previous location. Thus, in a P-type semiconductor, holes are constantly moving around within the crystal as electrons constantly try to fill them up.

P-N Junction

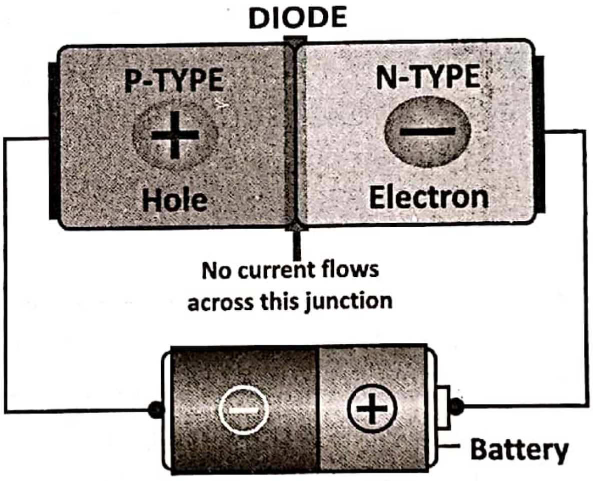
One of the crucial keys to solid state electronics is the nature of the P-N junction. When P-type and N-type materials are placed in contact with each other, the junction behaves very differently than either type of material alone. Specifically, current will flow readily in one direction (forward biased) but not in the other (reverse biased), creating the basic diode. This non-reversing behavior arises from the nature of the charge transport process in the two types of materials.

Forward biasing the p-n junction drives holes to the junction from the p-type material and electrons to the junction from the n-type material. At the junction the electrons and holes combine so that a continuous current can be maintained.

LIGHT-EMITTING DIODE (LED)

The light-emitting diode (LED) is one of today's most energy-efficient and rapidly-developing lighting technologies. Quality LED light bulbs last longer, are more durable, and offer comparable or better light quality than other types of lighting. LED has the potential to use at least 75% less energy, and last 25 times longer, than incandescent lighting.

The LED consists of a chip of semiconducting material doped with impurities to create a p-n junction. As in other diodes, current flows easily from the p-side, or anode, to the n-side, or cathode, but not in the reverse direction. Charge-carriers — electrons and holes — flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level and releases energy in the form of a photon. The wavelength of the light emitted, and thus its colour, depends on the band gap energy of the materials forming the p-n junction. The electrons dissipate energy in the form of heat for silicon and germanium diodes but in gallium arsenide phosphide (GaAsP) and gallium phosphide (GaP) semiconductors, the electrons dissipate energy by emitting photons. If the semiconductor is translucent, the junction becomes the source of light as it is emitted, thus becoming a light-emitting diode.



Advantages of LED Light

- Energy efficient - LEDs are now capable of outputting 135 lumens/watt.
- Long Lifetime - 50,000 hours or more if properly engineered.
- No warm-up period - LEDs light instantly – in nanoseconds.
- Not affected by cold temperatures - LEDs "like" low temperatures and will start up even in sub zero weather.
- Directional - With LEDs you can direct the light where you want it, thus no light is wasted.

- Excellent Color Rendering - LEDs do not wash out colours like other light sources such as fluorescents, making them perfect for displays and retail applications.
- Environmentally friendly - LEDs contain no mercury or other hazardous substances.
- Controllable - LEDs can be controlled for brightness and colour.

MODERN MATERIALS AND CHEMICALS (MCQs)

Note: Answers are Bold and Underlined.

1. **Porcelain is made for making crockery which is itself being prepared by:**
   (a) Mud (b) Soil (c) **Clay** (d) Silicon
2. **Ceramics can conduct**
   (a) Heat (b) Electricity
   (c) Both (a) and (b) (d) **Do not conduct both**
3. **Ceramics bear properties of:**
   (a) High melting and boiling point (b) Hard
   (c) Chemically unreactive (d) **All of these**
4. **Materials which can retain their strength above 550°C are known as:**
   (a) **Ceramics** (b) Polymers (c) Metals (d) Non-metals
5. **Which of the following is a synthetic Polymers:**
   (a) **Plastics** (b) Proteins (c) Lipids (d) Glycogen
6. **Polymer comes from Greek words "poly" which means "many" and "meros" which means __________.**
   (a) Metal (b) Material (c) **Part** (d) Plastic
7. **The engineering materials known as "plastics" are more correctly called __________.**
   (a) Polyvinyl chloride (b) **Polymers** (c) Polyethylene (d) Composites
8. **What is a combination of two or more materials that has properties that the components materials do not have by themselves?**
   (a) Compound (b) **Composite** (c) Mixture (d) Matrix
9. **Bakelite is a good:**
   (a) Conductor (b) **Insulator** (c) Metal (d) Liquid
10. **Natural substances made up of long molecules are:**
    (a) Plastic and rubber (b) **Rubber and wool**
    (c) Wool and plastic (d) Wood and plastic
11. **Long chains of atoms are linked by:**
    (a) Hydrogen (b) Oxygen (c) Nitrogen (d) **Carbon**
12. **Materials which doesn't allow any light to pass through them are called:**
    (a) Transparent materials (b) Translucent material

(c) Opaque materials (d) Abstract materials

13. **______ is a synthetic fibre used for making woollen clothes.**

(a) Acrylic (b) Polyester (c) Nylon (d) All of these

14. **Synthetic fibres are made using ______ as raw materials.**

(a) Woollen products (b) Polymers

(c) Cotton (d) Petrochemicals

15. **Fibre obtained by chemical treatment of wood pulp is called __________.**

(a) Natural silk (b) Rayon (c) Nylon (d) Polyester

16. **Nylon is obtained by _________.**

(a) Treating wood pulp (b) Solidifying water

(c) Mixing coal, air and water (d) Mixing chemicals

17. **_______ is polyester used for making bottles, utensils, films.**

(a) Ester (b) Nylon (c) PET (d) Rayon

18. **Three dimensional molecules with cross links are formed in the case of a _____.**

(a) Thermoplastic (b) Thermosetting plastic

(c) Both (a) and (b) (d) None of these

19. **Which is not polymer?**

(a) Glucose (b) Enzyme (c) Starch (d) Teflon

20. **Which of the followings is a polymer?**

(a) Glycogen (b) Proteins (c) Natural rubber (d) All of these

21. **If a substance such as heavy metals, pesticides accumulates in a body for a long time, it will be:**

(a) Passed out through egestion (b) Passed out through excretion

(c) Become insoluble in water

(d) Passed on to next consumer in food chain

22. **Pests may be not be destroyed through:**

(a) Vaccine (b) Insecticides (c) Herbicides (d) Pesticides

23. **Pesticides designed to kill birds are called:**

(a) Miticides (b) Birdicides (c) Avicides (d) Herbicides

24. **Pest control by changing crop spacing including crop rotation, pruning and weeding are part of the method of:**

(a) Chemical control (b) Mechanical control

(c) Biological control (d) Cultural control

25. **The three primary soil macro-nutrients are:**

(a) Carbon, oxygen, and water (b) Copper, cadmium, and carbon

(c) Potassium, phosphorus, and nitrogen (d) Boron, zinc, and manganese

26. **The process of accumulating higher and higher amounts of a toxic material such as heavy metals within the body of any animal is called:**

(a) Bioaccumulation (b) Biological amplification
(c) Biological half-life (d) Biological persistence

27. If nitrogen is main element of fertilizers then fertilizers are classified as:
(a) Structural fertilizers (b) Non-structural fertilizers
(c) Nitrogen fertilizers (d) Respiratory fertilizers

28. Increased ratio of chemical nutrients in ecosystem leads to:
(a) Triplication (b) Eutrophication
(c) Crystallization (d) Distillation

29. Greenhouse gas which can be emitted from storage of nitrogen-based fertilizers is:
(a) Nitrous oxide (b) Nitric oxide (c) Oxygen (d) Hydroxide

30. Organic fertilizers can be derived from:
(a) Animal materials (b) Poultry materials (c) Plant materials (d) All of these

31. DDT stands for:
(a) Dichloro-diphenyl tricholoroethane (b) Dichloro-triphenyl dichloroethane
(c) Dichlorino triammomium methane (d) Difluoro-diphenyl-tribromobutane

32. Which material may also be considered a semiconductor element?
(a) Ceramic (b) Carbon (c) Mica (d) Argon

33. In "p" type material, charge carriers would be:
(a) Electrons (b) Slower (c) Dopants (d) Holes

34. When is a P-N junction formed?
(a) In a large reverse biased region (b) In a depletion region
(c) The point at which two opposite doped materials come together
(d) Whenever there is a forward voltage drop

35. A commonly used pentavalent material is:
(a) Neon (b) Gallium (c) Boron (d) Arsenic

36. In "N" type material, majority carriers would be:
(a) Electrons (b) Dopants (c) Holes (d) Slower

37. Intrinsic semiconductor material is characterized by a valence shell of how many electrons?
(a) 6 (b) 2 (c) 4 (d) 1

38. Organic farming is the technique of raising crops through uses of:
(a) Manures (b) Biofertilizers (c) Resistant varieties (d) All of these

39. The most quickly available source of nitrogen to plants are:
(a) Amide fertilizers (b) Ammonia fertilizers
(c) Nitrate fertilizers (d) Ammonia nitrate fertilizers

40. IPM stand for:
(a) Integrated pest manufacture (b) Integrated plant management
(c) Integrated plant management (d) Integrated pest management

Part–II

General Ability

CHAPTER 16

ANALYTICAL REASONING

The term "**analytic reasoning**" refers to recognizing patterns and connections in a variety of information. Each analytical reasoning question is a logical puzzle, based on a given set of conditions. Analytical Reasoning test measures candidate's ability to analyse and to draw result from a complex situation by applying logic. The questions on analytical reasoning may be of any of the following types:

I. Classification Type Questions
II. Seating/Placing Arrangements
III. Comparison Type Questions
IV. Sequential order of things
V. Selection based on given conditions
VI. Questions involving family members their relationship, their professions, their preferences, etc.

GENERAL RULES TO CRACK ANALYTICAL REASONING QUESTIONS

There are a few rules, which help in solving analytical reasoning problems systematically. These rules help to frame the problem in the right perspective, organise thoughts and finally, crack the problem and its associated set of questions. A few such rules have been given below.

Read the passage carefully

Careful reading and analysis are necessary to determine the exact nature of the relationships involved in an analytical reasoning passage. Some relationships are fixed (for example, P and R *must* always work on the same project). Other relationships are variable (for example, Q must be assigned to *either* team 1 or team 3). Some relationships that are not stated explicitly in the conditions are implied by and can be deduced from those that are stated (for example, if one condition about paintings in a display specifies that Painting K must be to the left of Painting Y, and another specifies that Painting W must be to the left of Painting K, then it can be deduced that Painting W must be to the left of Painting Y).

Do not introduce unwarranted assumptions

In reading the conditions, do not introduce unwarranted assumptions. For instance, in a set of questions establishing relationships of height and weight among the members of a team, do not assume that a person who is taller than another person must weigh more than that person. All the information needed to answer each question is provided in the passage and the question itself.

The conditions are designed to be as clear as possible. Do not interpret the conditions as if they were intended to trick you. For example, if a question asks how many people could be eligible to serve on a committee, consider only those people named in the passage unless directed otherwise. When in doubt, read the conditions in their most obvious sense. Remember, however, that the language in the conditions is intended to be read for precise meaning. It is essential to pay particular attention to words that describe or limit relationships, such as *"only," "exactly," "never," "always," "must be," "cannot be,"* and the like. The result of this careful reading will be a clear picture of the structure of the relationships involved, including the kinds of relationships permitted, the participants in the relationships, and the range of possible actions or attributes for these participants.

Keep in mind question independence

Each question should be considered separately from the other questions in its set. No information, except what is given in the original conditions, should be carried over from one question to another.

Consider highlighting text and using diagrams

Many people find it useful to underline key points in the passage and in each question. In addition, it may prove very helpful to draw a diagram to assist you in finding the solution to the problem. Identify the most important condition, if any. Since the conditions are not given in any specific order, the student has to peruse through all of them and identify the key condition, which will provide the platform from where the problem can be solved. If there are any restrictions in the problem, like for example, one of the elements has always to be at one place and then start by putting that element there.

Organise the information

Drawing a diagram or sketch is the first step in organising information. Once the student has an idea of the problem, he has to organise the information in an easily comprehensible manner, i.e. he should try to associate it with whatever he feels comfortable. The student should put every bit of detail on paper, say, make notes. Some ways of organising information are

- **Grids and Tables:** Once the student has identified a particular structure of relationships, all the information can be arranged in the form of a multi-columnar grid. The different elements of the problem, as given by the conditions, must be entered onto the grid to facilitate a logical thinking process. It also helps in eliminating some of the answers provided in the solution.
- **Symbols and Notations:** If the student is comfortable substituting symbols for the different conditions, he should do so, as, this, like tables, provides a simplistic view of the problem. These may differ according to the type of problem and the comfort level of the student.

Elimination of answer choices

Some of the above rules do help one in eliminating answer choices. It is generally not advisable in case of analytical reasoning to start off by eliminating choices. As you will see, many problems require a bottom-up approach, but, that is only after a careful perusal and analysis of the conditions. Eliminate choices when the conditions are insufficient to answer the questions.

Answer all questions at the same time

Finally, answer all questions at the same time. In general, it is best to finish one passage before starting on another, because much time can be lost in returning to a passage and re-establishing familiarity with its relationships. However, if you are having great difficulty on one particular set of questions and are spending too much time on them, it may be to your advantage to skip that set of questions and go on to the next passage, returning to the problematic set of questions after you have finished the other questions in the section.

1 - CLASSIFICATION TYPE QUESTIONS

This type consists of questions in which certain items belonging to different groups or possessing different qualities are given along with some clues with the help of which the candidate is required to group and analyse the given items and answer the questions accordingly.

Example: 1

Read the following information carefully and answer the questions that follow:

i. There are six cities A, B, C, D, E and F.
ii. A is not a hill station.
iii. B and E are not historical places.
iv. D is not an industrial city.
v. A and D are not historical cities.
vi A and B are not alike.

1. **Which two cities are industrial centres?**
   (a) A and B (b) E and F (c) C and D (d) B and F
2. **Which two cities are historical centres?**
   (a) A and C (b) B and F (c) C and F (d) B and E
3. **Which two cities are hill stations?**
   (a) A and B (b) C and A (c) B and D (d) A and F
4. **Which city is a hill station and an industrial centre but not a historical place?**
   (a) E (b) F (c) A (d) B
5. **Which two cities are neither historical places nor industrial centres?**
   (a) A and B (b) D and E (c) F and C (d) B and D

Solution: The given information can be analysed as follows:

	A	B	C	D	E	F
Historical	X	X	√	x	x	√
Industrial	√	X	√	X	√	√
Hill Stations	X	√	√	√	√	√

Since A and B are not alike and because A is industrial, B cannot be industrial but only a hill station. So, we put a cross for B across Industrial.

1. Clearly. A, C, E and F are Industrial Centres. So, the answer is **(b)**.
2. Clearly. C and F are Historical places. So, the answer is **(c)**.
3. Clearly. B, C, D, E and F are Hill stations. So, the answer is **(c)**.
4. E alone is a Hill station and an Industrial centre but not a Historical place. So, the answer is **(a)**.
5. B and D are neither Historical places nor Industrial centres. So, the answer is **(d)**.

Example: 2

Read the following information carefully and answer the questions that follow:

- i. Five friends P, Q, R, S and T travelled to five different cities of Gwadar, Peshawar, Islamabad, Lahore and Hyderabad by five different modes of transport of Bus, Train, Aeroplane, Car and Boat from Karachi.
- ii. The person who travelled to Islamabad did not travel by boat.
- iii. R went to Lahore by car and Q went to Peshawar by aeroplane.
- iv. S travelled by boat whereas T travelled by train.
- v. Karachi is not connected by bus to Islamabad and Gwadar.

1. Which of the following combinations of person and mode is not correct?

(a) P — Bus (b) Q — Aeroplane

(c) R — Car (d) T — Aeroplane

2. Which of the following combinations is true for S?

(a) Islamabad — Bus (b) Gwadar — Bus

(c) Gwadar — Boat (d) Data inadequate

3. Which of the following combinations of place and mode is not correct?

(a) Islamabad — Bus (b) Peshawar — Aeroplane

(c) Lahore — Car (d) Gawadar — Boat

4. The person travelling to Islamabad went by which of the following modes?

(a) Bus (b) Train (c) Aeroplane (d) Car

5. Who among the following travelled to Islamabad?

(a) R (b) S (c) Data inadequate (d) T

Solution: The given information can be analysed as follows:

(a) **Mode of Transport:** R travels by Car, Q by Aeroplane, S by Boat and T by Train. Now, only P remains. So, P travels by Bus.

(b) **Place of Travel:** R goes to Lahore, Q to Peshawar. Now, bus transport is not available for Islamabad or Gwadar. So, P who travels by Bus goes to Hyderabad. S travels by boat and hence, by (ii), did not go to Islamabad. So, S goes to Gwadar. Now, only T remains. So, T goes to Islamabad.

Person	Place	Mode
P	Hyderabad	Bus
Q	Peshawar	Aeroplane

R	Lahore	Car
S	Gwadar	Boat
T	Islamabad	Train

1. Clearly, the incorrect combination is T — Aeroplane. So, the answer is **(d).**
2. Clearly, the correct combination for S is Gwadar — Boat. So, the answer is **(c).**
3. Clearly, the incorrect combination is Islamabad — Bus. So, the answer is **(a).**
4. Clearly, T travelled to Islamabad by Train. So, the answer is **(b).**
5. Clearly, T travelled to Islamabad. So, the answer is **(d).**

Example: 3

In a school, there were five teachers. A and B were teaching Urdu and English, C and B were teaching English and Geography, D and A were teaching Mathematics and Urdu and E and B were teaching History and French.

1. **Who among the teachers was teaching maximum number of subjects?**
   (a) A (b) B (c) C (d) D
2. **Which of the following pairs was teaching both Geography and Urdu?**
   (a) A and B (b) B and C (c) C and A (d) None of these
3. **More than two teachers were teaching which subject?**
   (a) History (b) Urdu (c) French (d) Geography
4. **D, B and A were teaching which of the following subjects?**
   (a) English only (b) Urdu and English
   (c) Urdu only (d) English and Geography
5. **Who among the teachers was teaching less than two subjects?**
   (a) A (b) B
   (c) D (d) None of these

Solution: The given information may be analysed as under:

	English	Urdu	Mathematics	Geography	History	French
A	√	√	√			
B	√	√		√	√	√
C	√			√		
D		√	√			
E					√	√

1. **(b)** B teaches maximum number of subjects i.e. 5
2. **(d)** Only B teaches both Urdu and Geography.
3. **(b)** Three teachers were teaching Urdu — A, B and D.
4. **(c)** D, B and A were teaching Urdu.
5. **(d)** None of the teachers was teaching less than two subjects.

2 - SEATING/PLACING ARRANGEMENTS

In this type of questions, some clues regarding seating or placing sequence (linear or circular) of some persons or items is given. The candidate is required to form the proper sequence using these clues and answer the questions accordingly.

Example: 1

Read the following information carefully and answer the questions given below:

i. Six persons A, B, C, D, E and F are sitting in two rows, three in each.

ii. E is not at the end of any row.

iii. D is second to the left of F.

iv. C, the neighbour of E, is sitting diagonally opposite to D.

v. B is the neighbour of F.

1. **Which of the following are sitting diagonally opposite to each other?**

   (a) F and C **(b)** D and A **(c)** A and C **(d)** A and F

2. **Who is facing B?**

   (a) A **(b)** C **(c)** D **(d)** E

3. **Which of the following are in the same row?**

   (a) A and E **(b)** E and D **(c)** C and B **(d)** A and B

4. **Which of the following are in one of the two rows?**

   (a) FBC **(b)** CEB **(c)** DBF **(d)** AEF

5. **After interchanging seat with E, who will be the neighbours of D in the new position.**

   (a) C and A **(b)** F and B **(c)** Only B **(d)** Only A

Solution: The given information can be analyzed as follows:

E is not at end. So, E can be in the middle of one of the rows.

D is second to the left of F. So, order of the row must be D— F.

C is neighbour of E and is sitting diagonally opposite to D means C is under F in the other row, i.e., D— F   — E C

B is the neighbour of F So DBF

So, the arrangement must be   D B F

A E C

1. Other than D and C (given), A and F are sitting diagonally opposite to each other, as seen in the arrangement. So, the answer is **(d).**
2. Clearly, E is opposite to B in the other row. So, E is facing B and the answer is (d).
3. Clearly, from amongst the given alternatives, A and E are in the same row. So, the answer is **(a).**
4. Clearly, from amongst the given alternatives, D, B and F are in the same row. So, the answer is **(c).**
5. Clearly, neighbours of E are A and C. So, on interchanging the seat with E, the new neighbours of D will be A and C. So, the answer is **(a).**

Example: 2

Eight books are kept on one another. Counting from the top, the second, fifth and sixth books are on Plays. Two books on Plays are between two books on Composition. One book of Plays is between two books on Poetry. While the book at the top of the book of Literature is a book of Composition.

1. **Which book is fourth from the top?**

   (a) Plays **(b)** Poetry **(c)** Composition **(d)** Literature

2. **Which book is on the top**

   (a) Plays **(b)** Composition **(c)** Literature **(d)** Poetry

3. **Which book is at the base?**

   (a) Composition **(b)** Poetry **(c)** Plays **(d)** Literature

Solution: We analyze the given information as follows:

Let C denote 'Composition', P denote 'Plays', Po denote 'Poetry' and L denote 'Literature'.

1	2	3	4	5	6	7	8
-	P	-	-	P	P	-	-
-	-	-	C	P	P	C	-
Po	P	Po	-	-	-	-	-
-	-	-	-	-	-	C	L

So, the arrangement becomes:

1	2	3	4	5	6	7	8
Po	P	Po	C	P	P	C	L

1. Clearly, the fourth book from the top is on Composition. So, the answer is **(c).**
2. Poetry book in on the top so answer is (c)
3. Literature book in on the base so answer is (d)

Example: 3

Read the following information and answer the questions that follow:

(i) Six friends, A, B, C, D, E and F are sitting in a closed circle facing the centre.

(ii) E is to the left of D.

(iii) C is between A and B.

(iv) F is between E and A.

1. **Who is to the left of B?**

   (a) A **(b)** C **(c)** D **(d)** E

2. **Who is to the right of C?**

   (a) A **(b)** B **(c)** D **(d)** E

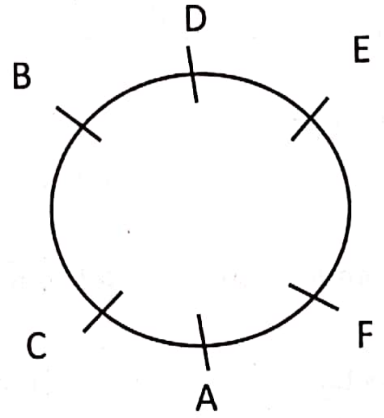
3. **Which of the above given statements is superfluous?**

   (a) (i) **(b)** (ii) **(c)** (iii) **(d)** None of these

Solution:

1. **(c) :** Clearly, in the circle the arrangement is as shown:

2. **(a) :** Clearly, A is to the right of C.
3. **(d) :** Since all the statements are necessary to determine the arrangement, none of them is superfluous.



3 - COMPARISON TYPE QUESTIONS

In such type of questions, clues are given regarding comparisons among a set of persons or things with respect to one or more qualities. The candidate is required to analyse the whole information, form a proper ascending/descending sequence and then answer the given questions accordingly.

Example: 1

Read the following information and answer the questions given below:

i. There are five friends Azhar, Misbah, Irfan, Sarfraz and Younas.

ii. Azhar is shorter than Misbah but taller than Younas.

iii. Irfan is the tallest.

iv. Sarfraz is a little shorter than Misbah and little taller than Azhar.

1. **Who is the shortest?**

   (a) Younas (b) Azhar (c) Sarfraz (d) Misbah

2. **If they stand in the order of their heights, who will be the middle?**

   (a) Misbah (b) Younas (c) Azhar (d) Sarfraz

3. **If they stand in the order of increasing heights, who will be the second?**

   (a) Sarfraz (b) Azhar (c) Younas (d) Misbah

4. **Who is the second tallest?**

   (a) Azhar (b) Misbah (c) Sarfraz (d) Younas

5. **Who is taller than Sarfraz but shorter than Irfan?**

   (a) Misbah (b) Younas (c) Azhar (d) Data inadequate

Solution: Let us denote the five boys by the first letter of their names, namely A, M, I, S and Y.

Then. $Y < A < S < M < I$

1. **(a) :** Younas is shortest.

2. **(d)** : Sarfraz is in the middle.
3. **(b)** : In the order of increasing heights i.e. shortest to tallest. Azhar is second.
4. **(b)** : Misbah is second tallest.
5. **(a)** : Misbah is taller than Sarfraz but shorter than Irfan .

Example: 2

Read the information given below and answer the questions that follow:

I. There is a group of five girls, Sanam, Hadya, Mahnoor, Rabia and Neelum
II. Sanam is second in height but younger than Mahnoor.
III. Hadya is taller than Rabia but younger in age.
IV. Mahnoor and Rabia are of the same age but Mahnoor is tallest among them.
V. Neelam is taller than Hadya and elder to Mahnoor.

1. **If they are arranged in the ascending order of height, who will be in third position?**
   (a) Rabia (b) Mahnoor
   (c) Rabia or Mahnoor (d) None of these
2. **If they are arranged in the descending order of their ages, who will be in fourth position?**
   (a) Rabia or Mahnoor (b) Sanam
   (c) Rabia (d) Sanam or Hadya
3. **To answer the question "who is the youngest person in the group", which of the given statements is superfluous?**
   (a) Only (i) (b) Only (ii)
   (c) Only (v) (d) Either (i) or (iv)

Solution: Let us denote the five girls by the letters S, H, M, R and N.

We first find the sequence of heights:

By (*iii*), we have: $R < H$.

By (*v*), we have : $H < N$.

Now, Mahnoor is tallest and Sanam is second in height.

So, the sequence of heights is : $R < H < N < S < M$.

Now, we determine the age sequence:

By (*ii*), we have: $S < M$.

By (*iii*), we have: $H < R$.

By (*iv*), we have: $R = M$.

By (*v*), we have: $M < N$.

So, the sequence of ages is: S or $H < R = M < N$

1. Clearly, in the increasing order of height, Neelam is in third position. Hence, the answer is **(d)**.
2. Clearly, in the descending order of ages, Sanam or Hadya can be in forth position. Hence, the answer is **(d)**.

3. Clearly, only statement (*i*) is not necessary. Hence, the answer is **(a)**.

4 - SEQUENTIAL ORDER OF THINGS

In this type of questions, some clues are given regarding the order of occurrence of certain events. The candidate is required to analyse the given information, frame the right sequence and then answer the questions accordingly.

Example: 1

Read the following information and answer the questions given below:

Six plays — A, B, C, D, E and F are to be staged, one on each day from Monday to Saturday. The schedule of the plays is to be in accordance with the following:

(i) A must be staged a day before E.
(ii) C must not be staged on Tuesday.
(iii) B must be staged on the day following the day on which F is staged.
(iv) D must be staged on Friday only and should not be immediately preceded by B.
(v) E must not be staged on the last day of the schedule.

1. **Which of the following plays immediately follows B?**
(a) A (b) C (c) D (d) E

2. **Which of the following plays is on Monday?**
(a) E (b) F (c) C (d) B

3. **Play D is between which of the following pairs of plays?**
(a) B and E (b) E and F (c) A and E (d) C and E

4. **Which of the following is the schedule of plays, with the order of their staging from Monday?**
(a) E, A, B, F, D, C (b) A, F, B, E, D, C
(c) A, F, B, C, D, E (d) None of these

5. **Play C cannot definitely be staged on which of the following days in addition to Tuesday?**
(a) Monday (b) Wednesday (c) Friday (d) Thursday

Solution: Clearly, D must be staged on Friday. A must be staged before E, i.e. order AE must be followed. But E cannot be staged on last day. Also, B must be staged immediately after F, i.e. order FB must be followed. But B cannot precede D. So, F and B can be staged on Monday and Tuesday and A and E on Wednesday and Thursday. C, which cannot be staged on Tuesday shall be staged on Saturday. Thus, the order followed will be:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
F	B	A	E	D	C

1. Clearly, A immediately follows B. So, the answer is **(a)**.
2. F will be played on Monday. So, the answer is **(b)**.
3. Play D is between E and C. So, the answer is **(d)**.
4. Clearly, order of staging of plays is F, B, A, E, D, C. So, the answer is **(d)**.

5. C cannot be staged on Friday as well because D has to be staged on that day **(c)**:

Example: 2

Read the following information carefully and answer the questions given below it:

(i) Eight doctors P, Q, R, S, T, U, V and W visit a charitable dispensary every day except on a holiday, i.e. Monday.

(ii) Each doctor visits for one hour from Tuesday to Sunday except Saturday. The timings are 9 a.m. to 1 p.m. and 2 p.m. to 6 p.m.; 1 p.m.; while. to 2 p.m. is lunch break.

(iii) On Saturday, it is open only in the morning, i.e. 9 a.m. to 1 p.m. and each doctor visits for only half an hour.

(iv) No other doctor visits the dispensary before doctor Q and after doctor U.

(v) Doctor W comes immediately after lunch break and is followed by R.

(vi) S comes in the same order as P in the afternoon session.

1. **Doctor P visits in between which of the following pairs of doctors ?**

(a) S and V **(b)** U and W **(c)** R and W **(d)** R and U

2. **At what time the visit of Doctor R would be over on Sunday?**

(a) 1 p.m. **(b)** 3 p.m. **(c)** 4 p.m. **(d)** 4.45 p.m.

3. **At what time the visit of Doctor T would be over on Saturday?**

(a) 10 a.m. **(b)** 11 a.m. **(c)** Either 10 a.m. or 11 a.m.

(d) Data inadequate

4. **If the lunch break and subsequent visiting hours are reduced by 15 minutes, at what time Doctor U is expected to attend the dispensary?**

(a) 3.15 p.m. **(b)** 4 p.m. **(c)** 5.15 p.m. **(d)** 4.45 p.m.

Solution: We first form the sequence of visit using (*iv*), (*v*) and (*vi*).

From (*iv*), we know that Q visits first and U visits last.

From (*v*), we know that W visits first after break and is followed by R.

From (*vi*), we know that P visits after break.

Thus, the sequence of visit after break becomes W R P U

Also, S has the same position in morning session as P in afternoon session. So, sequence of visit before break is Q, T/V, S, V/T.

Doctor	**Q**	**T/V**	**S**	**T/V**	**Break**	**W**	**R**	**P**	**U**
Time	10-11 am	10-11 am	11-12 am	12-1:00 pm	1-2 pm	2:3 pm	3-4 pm	4-5 pm	5-6 pm

1. **(d) :** Clearly, P visits between R and U.
2. **(c) :** The time of visit of W is 2 p.m. to 3 p.m., that of doctor R is 3 p.m. to 4 p.m. So, the visit of doctor R is over at 4 p.m.
3. **(c) :** Clearly, T visits either second or fourth. So, the time of visit on Saturday will be either 9.30 a.m. or 10.30 a.m. Thus, T's visit will be over at either 10 a.m. or 11 a.m.

4. (b) : Clearly, as mentioned, lunch break will be over and doctor W will visit at 1.45 p.m., doctor R will visit at 2.30 p.m., doctor P will visit at 3.15 p.m. and U will visit at 4 p.m.

5 - BLOOD RELATIONS WITH THEIR RELATIONSHIP AND PROFESSIONS

For solving this type of questions where persons engaged in different professions and they are also relatives to one another in which some clues are also given regarding relationship among different members of a family and their professions, qualities, dresses, preferences etc. On the basis of given information, students are advised to draw a family tree of the generations and analyse the whole information and then answer the given questions accordingly.

Example: 1

Read the following information carefully and answer the questions that are given below.

(i) P, Q, R, S, T and U are travelling in a bus.

(ii) There are two reporters, two technicians, one photographer and one writer in the group.

(iii) The photographer P is married to S who is a reporter.

(iv) The writer is married to Q who is in the same profession as that 'U'.

(v) P, R, Q, S are two married couples and nobody in the group has same profession.

(vi) U is brother of R.

1. **Which is the following is a pair of technicians?**

(a) RS (b) SU (c) PT (d) QU

2. **Which of the following is a pair of reporters ?**

(a) PQ (b) RT (c) ST (d) SU

3. **How is R related to U ?**

(a) Brother (b) Sister (c) Uncle (d) Both A and B

4. **Which of the followings is a couple ?**

(a) PQ (b) QR (c) QS (d) PT

5. **Which of the following is a pair of husbands?**

(a) PQ (b) PR

(c) QS (d) Cannot be determined

ANSWERS WITH EXPLANATION

From the statement (iii), The Photographer is married to S who is reporter. It means one couple is PS and another is (RQ) from statement (V) in six persons P's profession is photographer and S's profession is reporter, it means that in remaining four members, there are two technicians one writer and one reporter. The writer is married to Q who is in same profession as that of U. Another couple is RQ in which R is writer and Q and U have same profession because there are two technicians. Now, only T is there and his profession is reporter because there are two reporters and we have known one reporter which has been given in the statement (iii). It is clear that T must be the second reporter.

P	Q	R	S	T	U
↓	↓	↓	↓	↓	↓
Photo-Grapher	Technician	Writer	Reporter	Reporter	Technician

P + S - First Couple

R + Q - Second couple

ANSWERS

1. (d) 2. (c) 3. (d) 4. (b) 5. (d)

Example: 2

Study the following information carefully and answer the questions given below it:

(i) P, Q, R, S, T and U are six members in a family in which there are two married couple.

(ii) T, a teacher, is married to the doctor who is mother of R and U.

(iii) Q, the lawyer, is married to P

(iv) P has one son and one grandson.

(v) Of the two married ladies one is housewife.

(vi) There is one student and one male engineer in the family.

1. **How is P related to R?**

   (a) Grandfather (b) Mother (c) Sister (d). Grandmother

2. **Who among the following is housewife?**

   (a) P (b) Q (c) S (d) None of these

3. **How R related to U?**

   (a) Brother (b) Sister (c) Brother or Sister (d) Data inadequate

4. **Which of the following represents the group of females in the family?**

   (a) PSR (b) PSU

   (c) QTR (d) Data inadequate

5. **Which of the following is true about the grand daughter in the family?**

   (a) She is a lawyer (b) She is a student

   (c) She is an engineer (d) Data inadequate

ANSWERS WITH EXPLANATION

There are two couples in six members as mentioned in statement (iii). One couple is PQ and another couple is T and S and their two children in which one is student or another is male engineer. They are R and U. while T is teacher married to S doctor and Q lawyer is married to P who is housewife because one married lady P is house wife. P the housewife has one son who is married to T teacher and a grandson who is a male engineer from R and U. But between R and U sex cannot be determined. The following chart can well elaborate the professions and their relations.

P	Q	R	S	T	U
↓	↓	↓	↓	↓	↓
House wife	Lawyer	Student /Engineer	Doctor	Teacher	Student /Engineer

(1) Couple P + Q

(2) Couple S + T

ANSWERS

1. (d) P is the grandmother of R.
2. (d) P is the housewife
3. (c) R may be brother or Sister of U
4. (d) since, the sex of R and U is not given so the set of three females cannot be determined.
5. (b) The grand daughter is a student.

EXERCISE

Passage (Questions 1- 3)

A city wagon has exactly six stops on its route. The wagon first stops at stop one and then at stops two, three, four, five and six, respectively. After the wagon leaves stop six, the wagon returns to stop one, and repeats the cycle. The stops of the wagon are named as L, M, N, O, P, and Q.

P is the third stop. M is the sixth stop. The stop O is the stop immediately before Q. N is the stop immediately before L.

1. **If N is the fourth stop, which among the following must be the stop immediately before P?**

   (a) O (b) Q (c) N (d) L

2. **If L is the second stop, which among the following must be the stop immediately before M?**

   (a) N (b) L (c) P (d) Q

3. **In case a passenger gets on the bus at O, rides past one of the stops, and gets off at P. Which of the following must be true.**

   (a) L is stop six (b) Q is stop three (c) P is stop four (d) O is stop one

Passage (Question 4- 7)

There are six books on the table. Names of books are Math, English, Geography, Zoology, EDS and Urdu. Arrange these books in a shelf from bottom to top and follow these restrictions.

- Math must be placed at position 4
- Urdu must be placed at position 6
- EDS must be placed just above Zoology
- Math and English cannot be placed together

4. **The book of Geography occupies position.**

(a) 1 (b) 3 (c) 2 (d) 5

5. **Which of the following is true?**

(a) Urdu at 5 (b) EDS at 5 (c) English at 5 (d) Zoology at 2

6. **Which of following is NOT true?**

(a) Geography at 5 (b) Urdu at 6 (c) English at 1 (d) EDS at 2

7. **Which of following is proper arrangement of books?**

(a) EDS, Math, Geo, Urdu, Zoo, Eng (b) Eng, EDS, Zoo, Urdu, Math, Geo
(c) Eng, Zoo, EDS, Math, Geo, Urdu (d) Eng, Zoo, EDS, Urdu, Geo, Math

Passage (Question 8-10)

There are 6 pencils having Red, Green, Pink, Yellow, Black and White colours.

Pack these pencils in 3 boxes (A, B, C). Following conditions apply.

- No box can be kept empty.
- No box can hold more than 3 pencils.
- Green and Black pencils must be placed in the same box.
- Pink and Red pencils cannot be placed in the same box.

8. **Box A can have following pencils.**

(a) Black, Red, White (b) Green, Yellow, Pink
(c) Black, Green, Pink (d) Green, Red, Pink

9. **Which of following statement can be true?**

(a) Box B contains black and green pencils (b) Box A contains pink and red pencils
(c) Box A and box B contain three pencils each (d) Box C contains no pencil

10. **Which of the following statements cannot be true?**

(a) Pink is packed in box A, while red is packed in box B.
(b) Green is packed in box B and black is packed in box C.
(c) Each box has two pencils.
(d) Box A contains 3, box B contains 2, and box C contains 1 pencil.

Passage (Questions 11-14)

Three women – X, Y, and Z are travelling in a van with five children – A, B, C, D and E. The van has a driver's seat and one passenger seat in the front, and two benches behind the front seats, one bench behind other. Each bench has room for exactly three people. Everyone must sit in a seat or on a bench and seating is subject to the following restrictions:

- A women must sit on each bench.
- Either X or Y must sit in the driver's seat.
- C must sit immediately beside E.

11. **Which of the following can sit in the front passenger seat?**

(a) C (b) D (c) X (d) Y

12. **Which of the following groups of three can sit together on a bench?**

(a) A, C and E (b) A, C and Z (c) A, Y, and Z (d) B, D and Y

13. **If A sits immediately beside Z, which of the following CANNOT be true?**

(a) C sits immediately beside Y. (b) D sits immediately beside Z.

(c) B sits in the front passenger seat. (d) B sits on the same bench as X.

14. **If Y sits on a bench that is behind where C is sitting, which of the following must be true?**

(a) B sits in a seat or on a bench that is in front of where E is sitting.

(b) D sits in a seat or on a bench that is in front of where A is sitting.

(c) A sits on the same bench as B. (d) E sits on the same bench as Z.

Passage (Questions 15 - 18)

A builder will build five houses in new Housing Scheme on a street that currently has no houses. The builder will select from seven different models of houses L, M, N, O, P, Q and R. The Development Authority has placed the following restrictions on the builder: No model can be selected for more than one house. Either model O must be select or model R must be selected, but both cannot be selected. If model Q is selected, then model N must be selected. If model M is selected, then model O cannot be selected.

15. **Which of the following is an acceptable combination of models that can be selected for the street.**

(a) L, M, N, P, Q (b) L, M, P, Q, R (c) L, N, P, Q, R (d) M, N, O, P, Q

16. **If L, M and P are three of the models selected for the street, then which of the following must be the other two models selected?**

(a) N and O (b) N and Q (c) N and R (d) O and Q

17. **If model M is one of the models Selected for the street, then which of the following models must also be selected**

(a) L (b) O (c) P (d) R

18. **The model R is one model not selected for the street, then the other model NOT selected must be which of the following?**

(a) L (b) M (c) N (d) O

Questions 19 - 23

Six arms negotiators — M, O, P, R, S and T – are to be seated at a round table to discuss disarmament. There are exactly six chairs around the table. Each negotiator sits facing the centre of the table and is directly opposite a negotiator across the table. The seating arrangement is subject to the following restrictions:

- T cannot sit next to P.
- S cannot sit next to M.
- R must sit next to M.

19. **Which of the following is an acceptable sequence of negotiators around the table?**
(a) M. S, R, T, P, O
(b) M, S, T, P, R, O
(c) T, O, P, S, M, R
(d) T, R, M, P, S, O

20. **If M sits next to P, which of the following is a complete and accurate list of those who can sit next to P?**
(a) O
(b) O, S
(c) O, S, R
(d) R, S, T

21. **If T sits next to M and S sits next to R, which of the other negotiators must sit next to S?**
(a) M
(b) O
(c) P
(d) R

22. **If R sits next to S on S's right side, who must sit next to R on R's right side?**
(a) M
(b) O
(c) P
(d) S

23. **If T sits directly across the table from O, who must sit on either side of P?**
(a) M and O
(b) M and S
(c) O and R
(d) O and S

Passage (Questions 24-25)

Miss White holds a spelling bee each Friday Morning for eight of her best spellers. The first student eliminated is ranked 8th and the victor is ranked 1st. The weekly records show the following characteristics:

- Niko is always first.
- Liz is always right before Patrice.
- Jamal is always somewhere ahead of Quincy
- One student is always between Kelly and Ophelia with either of them being the better one.
- Marina and Patrice are always better than Jamal.

24. **Of the following records, which could be from Miss White's class?**
(a) Nikko, Liz, Patrice, Jamal, Kelly, Marina, Quincy, Ophelia.
(b) Nikko, Liz, Jamal, Patrice, Marine, Kelly, Quincy, Ophelia.
(c) Nikko, Marina, Jamal, Liz, Patrice, Kelly, Marina, Quincy, Ophelia.
(d) Nikko, Liz, Patrice, Marina, Jamal, Kelly, Quincy, Ophelia.

25. **On one record Patrice is 4th and Ophelia is 5th. Which of the following must also be true of that record?**
(a) Marina is 3rd
(b) Jamal is 2nd
(c) Kelly is 3rd
(d) Jamal is 8th

Passage (Questions 26-30)

An expedition of botanists C, D, E, F, G and H will break into two parties to collect specimens from either highland or lowland rain forest locations. With at least two botanists in each party, they will collect for two weeks and then meet. They can then reconstitute the parties and again proceed with either highland or lowland collecting.

The parties must conform to the following restrictions:

- H may not change locations.
- D may not work in the lowland locations.
- C and E have medical skills and must work different locations.
- C must work with F, her mentor.

26. **If C and H and two others go to the lowland location, the two others in the lowlands must be.**

(a) D and F (b) D and G (c) E and F (d) F and G

27. **Which of the following combinations of party and location is not possible if the parties have three members each?**

(a) C, F and D in the highlands.
(b) C, F and H in the lowlands.
(c) C, F and G in the lowlands.
(d) C, F and G in the highlands.

28. **If H and two others work the highlands, the two others must be.**

(a) C and F (b) C and G (c) D and E (d) D and G

29. **In which location must G work if F and H are in different parties, E works the highlands, and both parties have three botanists?**

(a) The lowlands with C and F
(b) The lowlands with E and H
(c) The highlands with E and H
(d) The lowlands with D and E

30. **After two weeks the parties meet and one botanist changes the party. The one who changes must be?**

(a) G (b) F (c) E (d) D

(Passage for Questions 31- 35)

A police team wants to establish that who was occupying which seat in a box at the cinema on the night a murder was committed. In the box, the rear seats are numbered 4, 5 and 6, and the front seats 1, 2 and 3. In both the rows numbering is from left to right. The existing evidence indicates that:

- Quent was in seat 5.
- Pani was in the seat behind Nehi.
- Ling and Morris were in different row.

31. **If the front row, from left to right, had Ling, Otto and Nehi, what must also be true?**

(a) Pani was in seat 5.
(b) Morris was in seat 5
(c) Morris was in seat 6.
(d) Morris was in seat 4.

32. **If one of the rows, left to right, had Nehi, Otto and Morris, then Ling must have been in which seat?**

(a) 1 (b) 2 (c) 3 (d) 6

33. **If Quent was directly behind Ling, what also must have been true?**

(a) Morriss was in seat 4.
(b) Otto was in seat 1.

(c) Otto was in seat 6. **(d)** Morris was right behind Otto.

34. **Which of the following must have been in the same row as Quent?**

(a) Ling **(b)** Otto **(c)** Morris **(d)** Pani

35. **If it could be proven, which of the following would make it possible for the police to determine where each person was sitting?**

(a) Otto was in seat 1. **(b)** Morris was in seat 2.

(c) Morris was in seat 3. **(d)** Nehi was in seat 1.

Passage (Questions 36- 39)

Six children are selected for the chorus line in the school play: Andrea, Beatrice, Consuelo, Denise, Eve and Florence. From left to right numbered 1 to 6 the following rules apply:

- Florence cannot be number 6.
- Denise must be immediately to the right of Consuelo.
- Andrea cannot be beside Beatrice.

36. **Which girl cannot be in the last position?**

(a) Andrea **(b)** Beatrice **(c)** Consuelo **(d)** Florence

37. **If Andrea is fifth, which girl must be sixth?**

(a) Beatrice **(b)** Consuelo **(c)** Denise **(d)** Eve

38. **If Denise is second and Florence is on her right, who must be fifth?**

(a) Andrea **(b)** Beatrice **(c)** Eve **(d)** Denise

39. **If Florence is third, where must Denise be?**

(a) Second **(b)** Second, fifth or sixth

(c) Four or fifth **(d)** Fifth or sixth

Passage (Questions 40 – 43)

A group of three objects must be selected from six objects – K, O, S, T, V, and W – according to the following conditions:

- Either K or S, or both, must be selected.
- Either O or V must be selected, but neither.
- V nor S can be selected with O.

40. **Which of the following is an acceptable selection of objects?**

(a) K, O, and S **(b)** K, S, and T **(c)** K, S, and V **(d)** O, S, and V

41. **Which of the following pairs of objects CANNOT both be among the objects selected?**

(a) K and O **(b)** K and T **(c)** O and W **(d)** T and W

42. **If S is selected, which of the following must also be among the objects selected?**

(a) K **(b)** O **(c)** T **(d)** V

43. **If V is not selected, which pair of objects must be among those selected?**

(a) O and W **(b)** K and T **(c)** K and W **(d)** K and O

Passage (Questions 44-47)

(a) Six friends P, Q, R, S, T and U are member of a club and play a different game of Football, Cricket, Tennis, Basketball, Badminton and Volleyball.

(b) T who is taller than P and S plays Tennis.

(c) The tallest among them plays basketball.

(d) The shortest among them plays Volleyball.

(e) Q and S neither play Volleyball nor Basketball.

(f) R plays Volleyball.

(g) T is between Q who plays football and P in order of height.

44. What does S play?

(a) Football
(b) Either Cricket or Badminton
(c) Cricket
(d) Badminton

45. Who among them is taller than R but shorter than P?

(a) T
(b) Data inadequate
(c) Q
(d) U

46. Who among them plays Basketball?

(a) S
(b) U
(c) Q
(d) R

47. Which of the following statements is NOT true?

(a) T is taller than R
(b) U is taller than Q
(c) P is shorter than R
(d) Q is taller than S

Passage (Questions 48- 52)

There are eight faculty members A, B, C, D, E, F, G and H in the institute each teaching a different subject.

- There are three lady members and of the eight four holding the Ph.D. Degree.
- E teaches psychology and is Ph.D.
- A teaches chemistry.
- The one who teaches economics is not Ph.D.
- No lady member teaches either commerce or law. Law faculty is not Ph.D.
- D and G do not teach either commerce or physics.
- H and C are lady member and not Ph.D.
- F who is Ph.D. teaches zoology.
- B and G are Ph.Ds and G is a lady member.

48. Which of the following statement is true?

(a) Three male members are Ph.D.
(b) Two lady members are Ph.D.
(c) The person who teaches economics is Ph.D.
(d) Person teaching zoology is not Ph.D.

49. What is the subject taught by G?

(a) Zoology.
(b) Either physics or Economics.
(c) Cannot be determined.
(d) Psychology.

50. **Who teaches physics?**

(a) C (b) H (c) Either H or C (d) Either C or G

51. **Which of the following combination is NOT correct?**

(a) Chemistry - Male - Not Ph.D. (b) Zoology-Male-Ph.D.

(c) Physics-Lady-Ph.D. (d) Economics-Lady-Not Ph.D.

52. **Which of the following lady member is/are Ph.D?**

(a) G (b) C and D (c) G and H (d) C

Passage (Questions 53 – 55)

A manager who has exactly four projects – F, G, H, and I – to undertake in a given month has made the following determinations:

- F has priority over G.
- H has priority over I.
- If one project has priority over another, the project with priority must be started earlier than the other one.

53. **Given only the determinations above, each of the following is a possible sequence in which the four projects could be started EXCEPT**

(a) F, G, H, I (b) F, H, G, I (c) F, H, I, G (d) H, G, F, I

54. **If each of the projects takes equally long to complete. It must be true that:**

(a) F is completed before H is completed. (b) F is completed before I is completed.

(c) G is completed before H is completed. (d) H is completed before I is completed.

55. **There would be exactly one order in which the four projects would have to be started if it were determined that:**

(a) F has priority over H (b) F has priority over I

(c) H has priority over G (d) I has priority over F

Questions 56 – 59

Exactly six detectives – S, T, U, X, Y, and Z --- take turns watching a suspect. To minimize the chance that the suspect will observe them or will escape their surveillance, the detectives will operate according to the following conditions:

- There must be exactly two detectives watching the suspect at all times.
- Whenever the suspect travels by car, either U or X must be one of the two detectives watching, but U and X cannot take a turn together.
- Whenever the suspect travels by train, either T or Z must be one of the two detectives watching, but T and Z cannot take a turn together.
- If Z is one of the detectives watching the suspect, S must be the other detective watching the suspect.
- S and X cannot take a turn together watching the suspect.

56. **If the suspect travels by train and T is not one of the detectives watching, the pair watching must be**

(a) S and Y (b) S and Z (c) U and Z (d) X and Y

57. If Y is one of the detectives watching the suspect, which of the following CANNOT be the other detective watching the suspect?

(a) S (b) T (c) U (d) X

58. If the suspect travels by car and S is one of the detectives watching, the other detective watching the suspect must be:

(a) T (b) U (c) X (d) Y

59. If a pair of detectives was watching while the suspect travelled by car, and the same pair of detectives continued watching after the suspect began to travel by train, one member of that pair of detectives must have been:

(a) T (b) U (c) X (d) Y

ANSWERS

1.	b	2.	d	3.	d	4.	d	5.	d	6.	d	7.	c
8.	c	9.	a	10.	b	11.	b	12.	d	13.	d	14.	d
15.	c	16.	c	17.	d	18.	b	19.	c	20.	b	21.	c
22.	a	23.	d	24.	d	25.	d	26.	d	27.	d	28.	c
29.	a	30.	a	31.	a	32.	d	33.	d	34.	d	35.	c
36.	d	37.	d	38.	c	39.	b	40.	c	41.	d	42.	d
43.	d	44.	b	45.	b	46.	b	47.	c	48.	a	49.	c
50.	c	51.	c	52.	a	53.	d	54.	d	55.	d	56.	b
57.	a	58.	b	59.	a								

CHAPTER 17

GENERAL MENTAL ABILITY

1. ANALOGY

'Analogy' means 'correspondence'.

In questions based on analogy, a particular relationship is given and another similar relationship has to be identified from the alternatives provided. Analogy tests are therefore meant to test a candidate's overall knowledge, power of reasoning and ability to think concisely and accurately. Below are given some common relationships which will help you detect most analogies better.

Kinds of Relationship

1. Instrument and Measurement

Example Barometer: Pressure

Barometer is an instrument used to measure pressure.

Some more examples are given below:

1. Thermometer: Temperature
2. Anemometer: Wind speed
3. Odometer: Speed
4. Scale: Length
5. Balance: Mass
6. Sphygmomanometer: Blood Pressure
7. Rain Gauge: Rain
8. Hygrometer: Humidity
9. Ammeter: Current
10. Screw Gauge: Thickness
11. Seismograph: Earthquake
12. Taseometer: Strains

2. Quantity and Unit

Example Length: meter

Meter is the unit of length.

Some more examples are given below:

1. Mass: Kilogram
2. Force: Newton
3. Energy: Joule
4. Resistance: Ohm
5. Volume: Litre
6. Angle: Radians
7. Power: Watt
8. Potential: Volt

9. Work: Joule
10. Time: Seconds
11. Current: Ampere
12. Luminosity: Candela
13. Pressure: Pascal
14. Area: Hectare
15. Temperature: Degrees
16. Conductivity: Mho
17. Magnetic field: Tesla

3. Individual and Group

Example Sailors: Crew

A group of sailors is called a crew.

Some more examples are given below:

1. Cattle: Herd
2. Flowers: Bouquet
3. Grapes: Bunch
4. Singer: Chorus
5. Artist: Troupe
6. Fish: Shoal
7. Sheep: Flock
8. Riders: Cavalcade
9. Bees: Swarm
10. Man: Crowd
11. Soldiers: Army
12. Nomads: Horde

4. Animal and Young one

Example Cow: Calf

Calf is the young one of cow.

Some more examples are given below:

1. Horse: Pony
2. Cat: Kitten
3. Sheep: Lamp
4. Butterfly: Caterpillar
5. Insect: Larva
6. Dog: Puppy
7. Hen: Chicken
8. Lion: Cub
9. Duck: Duckling
10. Man: Child

5. Male and Female

Example Horse: Mare

Mare is the female horse.

Some more examples are given below:

1. Dog: Bitch
2. Stag: Doe
3. Son: Daughter
4. Lion: Lioness
5. Sorcerer: Sorceress
6. Drone: Bee
7. Gentleman: Lady
8. Nephew: Niece

6. Individual and Class

Example Lizard: Reptile

Lizard belongs to the class of reptiles.

Some more examples are given below:

1. Man: Mammal
2. Ostrich: Bird
3. Snake: Reptile
4. Butterfly: Insect
5. Whale: Mammal
6. Rat: Rodent

7. Individual and Dwelling Place

Example Dog: Kennel

A dog lives in a kennel.

Some more examples are given below:

1. Bee: Apiary
2. Cattle: Shed
3. Lion: Den
4. Poultry: Farm
5. Monk: Monastery
6. Fish: Aquarium
7. Birds: Aviary
8. Horse: Stable

8. Study and Topic:

Example Ornithology: Birds

Ornithology is the study of birds:

Some more examples are given below:

1. Seismology: Earthquakes
2. Botany: Plants
3. Onomatology : Names
4. Ethnology : Human Races
5. Ontology : Reality
6. Herpetology : Amphibians
7. Pathology : Diseases
8. Astrology : Future
9. Anthropology : Man
10. Paleography : Ancient Writings

9. Worker and Tool

Example Blacksmith : Anvil

Anvil is the tool used by a blacksmith.

Some more examples are given below:

1. Carpenter : Saw
2. Woodcutter : Axe
3. Tailor : Needle
4. Labourer : Spade
5. Soldier : Gun
6. Sculptor : Chisel
7. Mason : Plumbline
8. Chef : Knife
9. Doctor : Stethoscope
10. Farmer : Plough

10. Tool and Action

Example Needle : Sew

A needle is used for sewing.

Some more examples are given below:

1. Knife : Cut
2. Sword : Slaughter
3. Mattock : Dig
4. Filter : Purify
5. Steering : Drive
6. Pen : Write

7. Spanner : Grip
8. Spoon : Feed
9. Microscope : Magnify
10. Gun : Shoot

11. Worker and Working Place

Example Chef : Kitchen

A chef works in a kitchen.

Some more examples are given below:

1. Farmer : Field
2. Warrior : Battlefield
3. Engineer : Site
4. Sailor : Ship
5. Pilot : Cockpit
6. Beautician : Parlour
7. Artist : Theatre
8. Actor : Stage
9. Mechanic : Garage
10. Lawyer : Court

12. Worker and Product

Example Mason : Wall

A mason builds a wall.

Some more examples are given below:

1. Farmer : Crop
2. Hunter : Prey
3. Carpenter: Furniture
4. Author : Book
5. Goldsmith : Ornaments
6. Butcher : Meat
7. Cobbler : Shoes
8. Poet : Poem
9. Editor : Newspaper
10. Teacher : Education

13. Product and Raw Material

Example Prism : Glass

Prism is made of glass.

Some more examples are given below:

1. Butter : Milk
2. Wall : Brick
3. Furniture : Wood
4. Shoes : Leather
5. Pullover : Wool
6. Metal : Ore
7. Rubber : Latex
8. Jaggery : Sugarcane
9. Wine : Grapes
10. Fabric : Yarn

14. Part and Whole Relationship

Example Pen : Nib.

Nib is a part of a pen.

Some more examples are given below:

1. Pencil : Lead
2. House : Kitchen
3. Fan : Blade
4. Class : Student
5. Room : Window
6. Aeroplane : Cockpit

15. Word and Intensity

Example Anger : Rage

Rage is of higher intensity than Anger.

Some more examples are given below:

1. Wish : Desire
2. Kindle : Burn
3. Sink : Drown
4. Quarrel : War
5. Error : Blunder
6. Famous : Renowned
7. Unhappy : Sad
8. Refuse : Deny
9. Crime : Sin
10. Moist : Drench

16. Word and Synonym

Example Abode : Dwelling

Abode means almost the same as *Dwelling*.

Thus, *Dwelling* is the synonym of *Abode*.

Some more examples are given below:

1. Blend : Mix
2. Ban : Prohibition
3. Assign : Allot
4. Vacant : Empty
5. Abduct : Kidnap
6. Dearth : Scarcity
7. Dissipate : Squander
8. Sedate : Calm
9. Brim : Edge
10. House : Home

17. Word and Antonym

Example Attack : Defend

Defend means the opposite of *Attack*.

Thus, *Defend* is the antonym of Attack.

Some more examples are given below:

1. Advance : Retreat
2. Cruel : Kind
3. Best : Worst
4. Fresh : Stale
5. Ignore : Notice
6. Initial : Final
7. Condense : Expand
8. Chaos : Peace
9. Create : Destroy
10. Gradual : Abrupt

COMPLETING THE ANALOGOUS PAIR

In this type of questions, two words are given. These words are related to each other in some way. Another word is also given. The candidate is required to find out the relationship between the first two words and choose the word from the given alternatives, which bears the same relationship to the third word, as the first two bear.

Example: Newspaper: Press: Cloth?

(a) Tailor
(b) Textile
(c) Fibre
(d) Factory

Solution: Just as newspaper is prepared in a press, cloth is manufactured in the factory. S answer is (d).

EXERCISE

1. **Moon : Satellite : : Earth : ?**
   (a) Sun (b) Planet (c) Solar system (d) Asteroid
2. **Forecast : Future : : Regret : ?**
   (a) Present (b) Atone (c) Past (d) Sins
3. **Influenza : Virus : : Typhoid : ?**
   (a) Bacillus (b) Parasite (c) Protozoa (d) Bacteria
4. **Fear : Threat : : Anger : ?**
   (a) Compulsion (b) Panic (c) Provocation (d) Force
5. **Melt : Liquid : : Freeze : ?**
   (a) Ice (b) Condense (c) Solid (d) Crystal
6. ***Doctor* is related to *Patient* in the same way as *Lawyer* is related to ________**
   (a) Customer (b) Accused (c) Magistrate (d) Client
7. ***Museum* is related to *Curator* in the same way as *Prison* is related to ________**
   (a) Manager (b) Monitor (c) Jailor (d) Warden
8. ***Soap* is related to *Wash* in the same way as *Broom* is related to __________**
   (a) Clean (b) Dust (c) Sweep (d) Floor
9. ***Wax* is related to *Grease* in the same way as *Milk* is related to __________**
   (a) Drink (b) Ghee (c) Curd (d) Protein
10. ***Bread* is related to *Bakery* in the same way as *Brick* is related to _________**
    (a) Mint (b) Kiln (c) Furnace (d) Mine

ANSWERS

1. (b) : Moon is a satellite and earth is a planet.
2. (c) : Forecast is for future happenings and Regret is for past actions.
3. (d) First is a disease caused by the second.
4. (c) : First arises from the second.
5. (c) : First is the process of formation of the second.
6. (d) : First works for the second.
7. (c) : First is managed by the second.
8. (c) : Second denotes the function of the first.
9. (c) : First is used to prepare the second.

10. **(b) :** Second is the place where the first is manufactured.

CHOOSING A SIMILAR WORD

In this type of questions, a group of three words is given, followed by four other words as alternatives. The candidate is required to choose the alternative, which is similar to the given three words.

Example: Sitar : Guitar : Tanpura

(a) Trumpet (b) Violin (c) Harmonium (d) Mridanga

Solution: Sitar, Guitar and Tanpura are all string instruments. Violin is also a string instrument. Hence, the answer is **(b).**

EXERCISE

Directions: *In each of the following questions, a group of three inter-related words is given. Choose a word from the given alternatives that belongs to the same group.*

1. **Calf : Kid : Pup**

(a) Infant (b) Young (c) Larva (d) Animal

2. **Ohm : Watt : Volt**

(a) Light (b) Electricity (c) Hour (d) Ampere

3. **Peas : Gram : Pulses**

(a) Rice (b) Barley (c) Beans (d) Coconut

4. **Jute : Cotton : Wool**

(a) Terylene (b) Silk (c) Rayon (d) Nylon

5. **Diamond : Sapphire : Ruby**

(a) Gold (b) Silver (c) Emerald (d) Bronze

ANSWERS

1. **(a) :** All are young ones of animals
2. **(d) :** All are measuring units of electricity.
3. **(c) :** Second denotes the function of the first.
4. **(b) :** All are natural fibres.
5. **(c) :** All are precious stones.

DETECTING ANALOGIES

In this type of questions, the candidate is required to trace out the hidden analogy or common characteristic among the given words or to choose the word which possesses the same characteristic as the given word.

Example: Judo: Karate: Taekwando

(a) They are names of martial arts.

(b) They can be performed by obese persons.

(c) They are performed on stage.

(d) They are important items of Asian Games.

Solution: Clearly, Judo, Karate and Taekwando are martial arts and alternative **(a)** is the most suitable description for all the three. Hence, the answer is **(a).**

EXERCISE

Directions: *Three words in bold letters are given in each question, which have something in common among themselves. Out of the four given alternatives, choose the most appropriate description about these three words.*

1. **Sandstone : Limestone : Coal**

(a) They are formed by metamorphic rocks.

(b) They are chemical minerals.

(c) They are found in river beds.

(d) They are formed in sedimentary rocks.

2. **Analects : Zend Avesta : Torah**

(a) These are places of worship.

(b) These are three sects of Muslims.

(c) These are names of religions.

(d) These are names of religious books.

3. **Mars : Mercury : Venus**

(a) They have no opposite motion.

(b) They are evil planets.

(c) They are the planets nearest to the earth.

(d) They have no corresponding lucky stone.

4. **Gnu : Emu : Curlew**

(a) These are fast runners.

(b) These are birds.

(c) These are small insects.

(d) These are animal.

5. **Chain : Link : Bridge**

(a) They all have hooks.

(b) They are related with ornaments.

(c) They join two parts.

(d) The terms are related with prison.

ANSWERS

1. (d) 2. (d) 3. (c) 4. (b) 5. (c)

THREE WORD ANALOGY

In this type of questions, a group of three inter-related words is given. The candidate is required to trace out the relationship among these three words and choose another group with similar analogy, from among the alternatives provided.

Example: Pen : Pencil : Ink

(a) Orange : Banana : Juice
(b) Table : Chair : Wood
(c) Cow : Milk : Curd
(d) Fish : Shark : Water

Solution: Clearly, pen contains ink and pencil belongs to the same category as pen, i.e. stationery. Similarly, orange contains juice and banana belongs to the same category as orange, i.e. fruits. Hence, the answer is (a).

EXERCISE

Directions: *In each of the following questions, some words are given which are related in some way. The same relationship obtains among the words in one of the four alternatives given under it. Find the correct alternative.*

1. **Magazine : Story : Article**
   (a) Tea : Milk : Sugar
   (b) Television : Newspaper : Entertainment
   (c) Bed : Quilt : Pillow
   (d) Novel : Drama : Literature
2. **Carnivorous : Tiger : Wolf**
   (a) Mango : Banana : Fruit
   (b) Worker : Master : Manager
   (c) Cat : Cow : Milk
   (d) Student : Boy : Girl
3. **Evaporation : Cloud : Rain**
   (a) Sneezing : Cough : Cold
   (b) Accident : Injury : Pain
   (c) Tanning : Leather : Purse
   (d) Bud : Flower : Fragrance
4. **Dog : Squirrel : Tail**
   (a) Cottage : Hut : Palace
   (b) Fish : Crocodile : Water
   (c) Horse : Ox : Horn
   (d) Truck : Scooter : Gear
5. **Chair : Door : Stick**
   (a) Tomato : Potato : Brinjal
   (b) Mason : Carpenter : Cobbler
   (c) Statue : Brick : Pitcher
   (d) Book : Pen : Notebook

ANSWERS

1. **(a):** First contains both the second and third.
2. **(d):** Both tiger and wolf are carnivorous animals. Similarly, both boys and girls are students.
3. **(b):** First causes the second and second leads to the third.
4. **(d):** Both dog and squirrel have tail. Similarly, both truck and scooter have gears.
5. **(c):** All the three are made up of the same raw material.

NUMBER ANALOGY

This section deals with two types of questions:

I. Choosing a similarly related pair as the given number pair on the basis of the relation between the numbers in each pair.

II. Choosing a number similar to a group of numbers on the basis of certain common properties that they possess.

Example 1: **3 : 11 : : 7 : ?**

(a) 22 (b) 29 (c) 18 (d) 51

Sol. Clearly, $3^2 + 2 = 11$.

Now, $7^2 + 2 = 51$.

So, if the first number is x, the second number is $x^2 + 2$. Thus, the relationship is $x : x^2 + 2$.

Hence, the answer is **(d)**.

Example 2: 324 : 162

(a) 64 : 36 (b) 2 : 1 (c) 22 : 10 (d) 134 : 112

Sol. Clearly, the relationship is 2x : x. This relationship exists in **(b)**. So, the correct answer is (b).

Example 3: Which number is like the given set of numbers? Given set: (3, 17, 31)

(a) 5 (b) 15 (c) 45 (d) 49

Sol. Clearly, the numbers in the given set are all prime numbers. 5 is also a prime number and so belongs to the same group. Hence, the answer is **(a)**.

Example 4: **Which set of numbers is like the given set? Given set : (48, 24, 12)**

(a) (44, 22, 10) (b) (46, 22, 11) (c) (40, 20, 10) (d) (42, 20, 10)

Sol. Clearly, in the given set, the first number is twice the second and the second number is twice the third.

Hence, the answer is **(c)**.

EXERCISE

1. **6 : 18 : : 4 : ?**

(a) 2 (b) 6 (c) 8 (d) 16

2. **21 : 3 : : 574 : ?**

(a) 23 (b) 82 (c) 97 (d) 113

3. **1 : 1 : : : 25 : ?**

(a) 26 (b) 125 (c) 240 (d) 625

4. **121 : 12 : : 25 : ?**

(a) 1 (b) 2 (c) 6 (d) 7

5. **42 : 20 : : 64 : ?**

(a) 31 (b) 32 (c) 33 (d) 34